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MANUAL OF ANATOMY

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CUNNINGHAM'S MANUAL

OF

PRACTICAL ANATOMY

REVISED AND EDITED BY

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SEVENTH EDITION

VOLUME SECOND

THORAX AND ABDOMEN

WITH 231 ILLUSTRATIONS, MANY OF WHICH ARE COLOURED

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PREFACE TO THE SEVENTH EDITION

In this edition the general text has been revised, many new figures, representing dissections, sections and radiographs, have been introduced. The instructions for dissection have been printed in a distinctive indented type; in many cases they have been rewritten and in some cases amplified.

The latter changes, together with the additional figures, have caused so much increase of size that it has been deemed advisable to publish the book in three volumes. Vol. I.: Superior Extremity and Inferior Extremity; Vol. II.: Thorax and Abdomen; Vol. III.: Head and Neck.

As was the case in previous editions, I am indebted to Dr. E. B. Jamieson for many suggestions, for his invaluable help in the revision of the text and for the preparation of the Index.

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ARTHUR ROBINSON.

Oct. 11, 1919.

CONTENTS

THORAX.

ABDOMEN.

A GLOSSARY

OF THE

INTERNATIONAL (B.N.A.) ANATOMICAL TERMINOLOGY

GENERAL TERMS.

TERMS INDICATING SITUATION AND DIRECTION.

Longitudinalis	Longitudinal	Referring to the long axis of the body.
Verticalis	Vertical	Referring to the position of the long axis of the body in the erect posture.
Anterior Posterior	Anterior Posterior	Referring to the front and back of the body or of the limbs.
Ventral Dorsal	Ventral Dorsal	Referring to the anterior and posterior aspects, respectively, of the body, and to the flexor and extensor aspects of the limbs, respectively.
Cranial Caudal	Cranial Caudal	Referring to position nearer the head or the tail end of the long axis. Used only in reference to parts of the head, neck, or trunk.
Superior Inferior	Superior Inferior	Used in reference to the head, neck, and trunk. Equivalent to cranial and caudal respectively.
Proximalis Distalis	Proximal Distal	Used only in reference to the limbs. Proximal nearer the attached end. Distal nearer the free end.
Sagittalis	Sagittal	Used in reference to planes parallel with the sagittal suture of the skull, *i.e.* vertical antero-posterior planes.
Frontalis	Frontal	Used in reference to planes parallel with the coronal suture of the skull, *i.e.* transverse vertical planes.

Horizontalis	Horizontal	Used in reference to planes at right angles to vertical planes.
Medianus	Median	Referring to the median vertical antero-posterior plane of the body.
Medialis Lateralis	Medial Lateral	Referring to structures relatively nearer to or further away from the median plane.
Intermedius	Intermediate	Referring to structures situated between more medial and more lateral structures.
Superficialis Profundus	Superficial Deep	Referring to structures nearer to and further away from the surface.
Externus Internus	External Internal	Referring, with few exceptions, to the walls of cavities and hollow organs. *Not* to be used as synonymous with medial and lateral.
Ulnaris Radialis	Ulnar Radial	Used in reference to the medial and lateral borders of the forearm, respectively.
Tibial Fibular	Tibial Fibular	Used in reference to the medial and lateral borders of the leg, respectively.

THE BONES.

B.N.A. Terminology.	Old Terminology.
Vertebræ	**Vertebræ**
Fovea costalis superior	Incomplete facet for head of rib, upper
Fovea costalis inferior	Incomplete facet for head of rib, lower
Fovea costalis transversalis	Facet for tubercle of the rib
Radix arcus vertebræ	Pedicle
Atlas	**Atlas**
Fovea dentis	Facet for odontoid process
Epistropheus	**Axis**
Dens	Odontoid process
Sternum	**Sternum**
Corpus sterni	Gladiolus
Processus xiphoideus	Ensiform process
Incisura jugularis	Supra-sternal notch
Planum sternale	Anterior surface
Ossa Cranii.	**Bones of Skull.**
Os frontale	**Frontal**
Spina frontalis	Nasal spine
Processus zygomaticus	External angular process
Facies cerebralis	Internal surface
Facies frontalis	Frontal surface
Pars orbitalis	Orbital plate

B.N.A. Terminology.	Old Terminology.
Os parietale	**Parietal**
Lineæ temporales	Temporal ridges
Sulcus transversus	Groove for lateral sinus
Sulcus sagittalis	Groove for sup. long. sinus
Os occipitale	**Occipital**
Canalis hypoglossi	Anterior condyloid foramen
Foramen occipitale magnum	Foramen magnum
Canalis condyloideus	Posterior condyloid foramen
Sulcus transversus	Groove for lateral sinus
Sulcus sagittalis	Groove for sup. long. sinus
Clivus	Median part of upper surface of basi-occipital
Linea nuchæ suprema	Highest curved line
Linea nuchæ superior	Superior curved line
Linea nuchæ inferior	Inferior curved line
Os sphenoidale	**Sphenoid**
Crista infratemporalis	Pterygoid ridge
Sulcus chiasmatis	Optic groove
Crista sphenoidalis	Ethmoidal crest
Spina angularis	Spinous process
Lamina medialis processus pterygoidei	Internal pterygoid plate
Lamina lateralis processus pterygoidei	External pterygoid plate
Canalis pterygoideus [Vidii]	Vidian canal
Fossa hypophyseos	Pituitary fossa
Sulcus caroticus	Cavernous groove
Conchæ sphenoidales	Sphenoidal turbinal bones
Hamulus pterygoideus	Hamular process
Canalis pharyngeus	Pterygo-palatine canal
Tuberculum sellæ	Olivary eminence
Fissura orbitalis superior	Sphenoidal fissure
Os temporale	**Temporal Bone**
Canalis facialis [Fallopii]	Aqueduct of Fallopius
Hiatus canalis facialis	Hiatus Fallopii
Vagina processus styloidei	Vaginal process of tympanic bone
Incisura mastoidea	Digastric fossa
Impressio trigemini	Impression for Gasserian ganglion
Eminentia arcuata	Eminence for sup. semicircular canal
Sulcus sigmoideus	Fossa sigmoidea
Fissura petrotympanica	Glaserian fissure
Fossa mandibularis	Glenoid cavity
Semicanalis tubæ auditivæ	Eustachian tube
Os ethmoidale	**Ethmoid**
Labyrinthus ethmoidalis	Lateral mass
Lamina papyracea	Os planum
Processus uncinatus	Unciform process

B.N.A. Terminology.	Old Terminology.
Os lacrimale	**Lachrymal Bone**
Hamulus lacrimalis	Hamular process
Crista lacrimalis posterior	Lachrymal crest
Os nasale	**Nasal Bone**
Sulcus ethmoidalis	Groove for nasal nerve
Maxilla	**Superior Maxillary Bone**
Facies anterior	Facial or external surface
Facies infra-temporalis	Zygomatic surface
Sinus maxillaris	Antrum of Highmore
Processus frontalis	Nasal process
Processus zygomaticus	Malar process
Canales alveolares	Posterior dental canals
Canalis naso-lacrimalis	Lacrimal groove
Os incisivum	Premaxilla
Foramen incisivum	Anterior palatine foramen
Os palatinum	**Palate Bone**
Pars perpendicularis	Vertical plate
Crista conchalis	Inferior turbinate crest
Crista ethmoidalis	Superior turbinate crest
Pars horizontalis	Horizontal plate
Os zygomaticum	**Malar Bone**
Processus temporalis	Zygomatic process
Processus fronto-sphenoidalis	Frontal process
Foramen zygomatico-orbitale	Tempora-malar canal
Foramen zygomatico-faciale	Malar foramen
Mandibula	**Inferior Maxillary Bone**
Spina mentalis	Genial tubercle or spine
Linea obliqua	External oblique line
Linea mylohyoidea	Internal oblique line
Incisura mandibulæ	Sigmoid notch
Foramen mandibulare	Inferior dental foramen
Canalis mandibulæ	Inferior dental canal
Protuberantia mentalis	Mental process

The Skull as a Whole.

Ossa suturarum	Wormian bones
Foveolæ granulares (Pacchioni)	Pacchionian depressions
Fossa pterygo-palatina	Spheno-maxillary fossa
Canalis pterygo-palatinus	Posterior palatine canal
Foramen lacerum	Foramen lacerum medium
Choanæ	Posterior nares
Fissura orbitalis superior	Sphenoidal fissure
Fissura orbitalis inferior	Spheno-maxillary fissure

Upper Extremity.

B.N.A. Terminology.	Old Terminology.
Clavicula	**Clavicle**
Tuberositas coracoidea	Impression for conoid ligament
Tuberositas costalis	Impression for rhomboid ligament
Scapula	**Scapula**
Incisura scapularis	Supra-scapular notch
Angulus lateralis	Anterior or lateral angle
Angulus medialis	Superior angle
Humerus	**Humerus**
Sulcus intertubercularis	Bicipital groove
Crista tuberculi majoris	External lip
Crista tuberculi minoris	Internal lip
Facies anterior medialis	Internal surface
Facies anterior lateralis	External surface
Margo medialis	Internal border
Margo lateralis	External border
Sulcus nervi radialis	Musculo-spiral groove
Capitulum	Capitellum
Epicondylus medialis	Internal condyle
Epicondylus lateralis	External condyle
Ulna	**Ulna**
Incisura semilunaris	Greater sigmoid cavity
Incisura radialis	Lesser sigmoid cavity
Crista interossea	External or interosseous border
Facies dorsalis	Posterior surface
Facies volaris	Anterior surface
Facies medialis	Internal surface
Margo dorsalis	Posterior border
Margo volaris	Anterior border
Radius	**Radius**
Tuberositas radii	Bicipital tuberosity
Incisura ulnaris	Sigmoid cavity
Crista interossea	Internal or interosseous border
Facies dorsalis	Posterior surface
Facies volaris	Anterior surface
Facies lateralis	External surface
Margo dorsalis	Posterior border
Margo volaris	Anterior border
Carpus	**Carpus**
Os naviculare	**Scaphoid**
Os lunatum	**Semilunar**
Os triquetrum	**Cuneiform**
Os multangulum majus	**Trapezium**
Os multangulum minus	**Trapezoid**
Os capitatum	**Os magnum**
Os hamatum	**Unciform**

Lower Extremity.

B.N.A. Terminology.	Old Terminology.
Os coxæ	**Innominate Bone**
Linea glutæa anterior	Middle curved line
Linea glutæa posterior	Superior curved line
Linea terminalis	Margin of inlet of true pelvis
Spina ischiadica	Spine of the ischium
Incisura ischiadica major	Great sacro-sciatic notch
Incisura ischiadica minor	Lesser sacro-sciatic notch
Tuberculum pubicum	Spine of pubis
Ramus inferior oss. pubis	Descending ramus of pubis
Ramus superior oss. pubis	Ascending ramus of pubis
Ramus superior ossis ischii	Body of ischium
Ramus inferior oss. ischii	Ramus of ischium
Pecten ossis pubis	Pubic part of ilio-pectineal line
Facies symphyseos	Symphysis pubis
Pelvis	**Pelvis**
Pelvis major	False pelvis
Pelvis minor	True pelvis
Apertura pelvis minoris superior	Pelvic inlet
Apertura pelvis minoris inferior	Pelvic outlet
Linea terminalis	Margin of inlet of true pelvis
Femur	**Femur**
Fossa trochanterica	Digital fossa
Linea intertrochanterica	Spiral line
Crista intertrochanterica	Post. intertrochanteric line
Condylus medialis	Inner condyle
Condylus lateralis	Outer condyle
Epicondylus medialis	Inner tuberosity
Epicondylus lateralis	Outer tuberosity
Tibia	**Tibia**
Condylus medialis	Internal tuberosity
Condylus lateralis	External tuberosity
Eminentia intercondyloidea	Spine
Tuberositas tibiæ	Tubercle
Malleolus medialis	Internal malleolus
Fibula	**Fibula**
Malleolus lateralis	External malleolus
Apex capituli fibulæ	Styloid process

Bones of the Foot.

Talus	**Astragalus**
Calcaneus	**Os calcis**
Tuber calcanei	Tuberosity of
Processus medialis tuberis calcanei	Inner
Processus lateralis tuberis calcanei	Outer
Os cuneiforme primum	**Inner cuneiform**
Os cuneiforme secundum	**Middle cuneiform**
Os cuneiforme tertium	**Outer cuneiform**

THE LIGAMENTS.

Ligaments of the Spine.

B.N.A. Terminology.	Old Terminology.
Lig. longitudinale anterius	Anterior common ligament
Lig. longitudinale posterius	Posterior common ligament
Lig. flava	Ligamenta subflava
Membrana tectoria	Posterior occipito-axial ligament
Articulatio atlanto-epistrophica	Joint between the atlas and the axis
Lig. alaria	Odontoid or check ligaments
Lig. apicis dentis	Suspensory ligament

The Ribs.

Lig. capituli costæ radiatum	Anterior costo-vertebral or stellate ligament
Lig. sterno-costale interarticulare	Interarticular chondro-sternal ligament
Lig. sterno-costalia radiata	Anterior and posterior chondro-sternal ligament
Lig. costoxiphoidea	Chondro-xiphoid ligaments

The Jaw.

Lig. temporo-mandibulare	External lateral ligament of the jaw
Lig. spheno-mandibulare	Internal lateral ligament of the jaw
Lig. stylo-mandibulare	Stylo-maxillary ligament

Upper Extremity.

Lig. costo-claviculare	Rhomboid ligament
Labrum glenoidale	Glenoid ligament
Articulatio radio-ulnaris proximalis	Superior radio-ulnar joint
Lig. collaterale ulnare	Internal lateral ligament of elbow joint
Lig. collaterale radiale	External lateral ligament
Lig. annulare radii	Orbicular ligament
Chorda obliqua	Oblique ligament of ulna
Articulatio radio-ulnaris distalis	Inferior radio-ulnar joint
Discus articularis	Triangular fibro-cartilage
Recessus sacciformis	Membrana sacciformis
Lig. radio-carpeum volare	Anterior ligament of the radio-carpal joint
Lig. radio-carpeum dorsale	Posterior ligament of the radio-carpal joint
Lig. collaterale carpi ulnare	Internal lateral ligament of the wrist joint

B.N.A. Terminology.	Old Terminology.
Lig. collaterale carpi radiale	External lateral ligament of the wrist joint
Articulationes intercarpæ	Carpal joints
Lig. accessoria volaria	Palmar ligaments of the metacarpo-phalangeal joints
Lig. capitulorum (oss. metacarpalium) transversa	Transverse metacarpal ligament
Lig. collateralia	Lateral phalangeal ligaments

The Lower Extremity.

Lig. arcuatum	Subpubic ligament
Lig. sacro-tuberosum	Great sacro-sciatic ligament
Processus falciformis	Falciform process
Lig. sacro-spinosum	Small sacro-sciatic ligament
Labrum glenoidale	Cotyloid ligament
Zona orbicularis	Zonular band
Ligamentum iliofemorale	Y-shaped ligament
Lig. ischio-capsulare	Ischio-capsular band
Lig. pubo-capsulare	Pubo-femoral ligament
Lig. popliteum obliquum	Ligament of Winslow
Lig. collaterale fibulare	Long external lateral ligament
Lig. collaterale tibiale	Internal lateral ligament
Lig. popliteum arcuatum	Arcuate popliteal ligament
Meniscus lateralis	External semilunar cartilage
Meniscus medialis	Internal semilunar cartilage
Plica synovialis patellaris	Lig. mucosum
Plicæ alares	Ligamenta alaria
Articulatio tibio-fibularis	Superior tibio-fibular articulation
Lig. capituli fibulæ	Anterior and posterior superior tibio-fibular ligaments
Syndesmosis tibio-fibularis	Inferior tibio-fibular articulation
Lig. deltoideum	Internal lateral ligament of ankle
Lig. talo-fibulare anterius	Anterior fasciculus of external lateral ligament
Lig. talo-fibulare posterius	Posterior fasciculus of external lateral ligament
Lig. calcaneo-fibulare	Middle fasciculus of external lateral ligament
Lig. talo-calcaneum laterale	External calcaneo-astragaloid ligament
Lig. talo-calcaneum mediale	Internal calcaneo-astragaloid ligament
Lig. calcaneo-naviculare plantare	Inferior calcaneo-navicular ligament
Lig. talo-naviculare	Astragalo-scaphoid ligament
Pars calcaneo-navicularis } lig. bifurcatum	Superior calcaneo-scaphoid ligament
Pars calcaneo-cuboidea } lig. bifurcatum	Internal calcaneo-cuboid ligament

THE MUSCLES.

Muscles of the Back.

Superficial.

B.N.A. Terminology.	Old Terminology.
Levator scapulæ	Levator anguli scapulæ

Muscles of the Chest.

Serratus anterior	Serratus magnus

Muscles of Upper Extremity.

Biceps brachii	Biceps
Lacertus fibrosus	Bicipital fascia
Brachialis	Brachialis anticus
Triceps brachii	Triceps
Caput mediale	Inner head
Caput laterale	Outer head
Pronator teres	Pronator radii teres
Caput ulnare	Coronoid head
Brachio-radialis	Supinator longus
Supinator	Supinator brevis
Extensor carpi radialis longus	Extensor carpi radialis longior
Extensor carpi radialis brevis	Extensor carpi radialis brevior
Extensor indicis proprius	Extensor indicis
Extensor digiti quinti proprius	Extensor minimi digiti
Abductor pollicis longus	Extensor ossis metacarpi pollicis
Abductor pollicis brevis	Abductor pollicis
Extensor pollicis brevis	Extensor primi internodii pollicis
Extensor pollicis longus	Extensor secundi internodii pollicis
Lig. carpi transversum	Anterior annular ligament
Lig. carpi dorsale	Posterior annular ligament

Muscles of Lower Extremity.

Tensor fasciæ latæ	Tensor fasciæ femoris
Canalis adductorius (Hunteri)	Hunter's canal
Trigonum femorale (fossa Scarpæ major)	Scarpa's triangle
Canalis femoralis	Crural canal
Annulus femoralis	Crural ring
M. quadriceps femoris—	Quadriceps—
Rectus femoris	Rectus femoris
Vastus lateralis	Vastus externus
Vastus intermedius	Crureus
Vastus medialis	Vastus internus
M. articularis genu	Subcrureus
Tibialis anterior	Tibialis anticus

B.N.A. Terminology.	Old Terminology.
Tendo calcaneus	Tendo Achillis
Tibialis posterior	Tibialis posticus
Quadratus plantæ	Accessorius
Lig. transversum cruris	Upper anterior annular ligament
Lig. cruciatum cruris	Lower anterior annular ligament
Lig. laciniatum	Internal annular ligament
Retinaculum musculorum peronæorum superius Retinaculum musculorum peronæorum inferius	External annular ligament

Axial Muscles.

Muscles of the Back.

Serratus posterior superior	Serratus posticus superior
Serratus posterior inferior	Serratus posticus inferior
Splenius cervicis	Splenius colli
Sacro-spinalis	Erector spinæ
Ilio-costalis—	**Ilio-costalis**—
Lumborum	Sacro-lumbalis
Dorsi	Accessorius
Cervicis	Cervicalis ascendens
Longissimus—	**Longissimus**—
Dorsi	Dorsi
Cervicis	Transversalis cervicis
Capitis	Trachelo-mastoid
Spinalis—	**Spinalis**—
Dorsi	Dorsi
Cervicis	Colli
Capitis	Capitis
Semispinalis—	**Semispinalis**—
Dorsi	Dorsi
Cervicis	Colli
Capitis	Complexus
Multifidus	Multifidus spinæ

Muscles of Head and Neck.

Epicranius	Occipito-frontalis
Galea aponeurotica	Epicranial aponeurosis
Procerus	Pyramidalis nasi
Pars transversa (nasalis)	Compressor naris
Pars alaris (nasalis)	Dilatores naris
Auricularis anterior	Attrahens aurem
Auricularis posterior	Retrahens aurem
Auricularis superior	Attollens aurem
Orbicularis oculi	Orbicularis palpebrarum
Pars lacrimalis	Tensor tarsi

B.N.A. Terminology.	Old Terminology.
Triangularis	Depressor anguli oris
Quadratus labii superioris—	
Caput zygomaticum	Zygomaticus minor
Caput infraorbitale	Levator labii superioris
Caput angulare	Levator labii superioris alæque nasi
Zygomaticus	Zygomaticus major
Caninus	Levator anguli oris
Quadratus labii inferioris	Depressor labii inferioris
Mentalis	Levator menti
Platysma	Platysma myoides
Sterno-thyreoid	Sterno-thyroid
Thyreo-hyoid	Thyro-hyoid

Muscles and Fascia of the Orbit.

Fascia bulbi	Capsule of Tenon
Septum orbitale	Palpebral ligaments
Rectus lateralis	Rectus externus
Rectus medialis	Rectus internus

Muscles of the Tongue.

Genio-glossus	Genio-hyo-glossus
Longitudinalis superior	Superior lingualis
Longitudinalis inferior	Inferior lingualis
Transversus linguæ	Transverse fibres
Verticalis linguæ	Vertical fibres

Muscles of the Pharynx.

Pharyngo-palatinus	Palato-pharyngeus
M. uvulæ	Azygos uvulæ
Levator veli palatini	Levator palati
Tensor veli palatini	Tensor palati
Glosso-palatinus	Palato-glossus

Deep Lateral Muscles of Neck.

Scalenus anterior	Scalenus anticus
Scalenus posterior	Scalenus posticus
Longus capitis	Rectus capitis anticus major
Rectus capitis anterior	Rectus capitis anticus minor

Muscles of Thorax.

Transversus thoracis	Triangularis sterni
Diaphragma	Diaphragm
Crus mediale Crus intermedium Crus laterale	Crura and origins from arcuate ligaments
Arcus lumbo-costalis medialis (Halleri)	Ligamentum arcuatum internum
Arcus lumbo-costalis lateralis (Halleri)	Ligamentum arcuatum externum

Muscles of the Abdomen.

B.N.A. Terminology.	Old Terminology.
Ligamentum inguinale (Pouparti)	Poupart's ligament
Ligamentum lacunare (Gimbernati)	Gimbernat's ligament
Fibræ intercrurales	Intercolumnar fibres
Ligamentum inguinale reflexum (Collesi)	Triangular fascia
Annulus inguinalis subcutaneus	External abdominal ring
Crus superius	Internal pillar
Crus inferius	External pillar
Falx aponeurotica inguinalis	Conjoined tendon
M. transversus abdominis	Transversalis muscle
Linea semicircularis (Douglasi)	Fold of Douglas
Annulus inguinalis abdominalis	Internal abdominal ring

Perineum and Pelvis.

Transversus perinei superficialis	Transversus perinei
M. sphincter urethræ membranaceæ	Compressor urethræ
Diaphragma urogenitale	Deep transverse muscle and sphincter urethræ
Fascia diaphragmatis urogenitalis superior	Deep layer of triangular ligament
Fascia diaphragmatis urogenitalis inferior	Superficial layer of the triangular ligament
Arcus tendineus fasciæ pelvis	White line of pelvis
Ligamenta puboprostatica	Anterior and lateral true ligaments of bladder
Fascia diaphragmatis pelvis superior	Visceral layer of pelvic fascia
Fascia diaphragmatis pelvis inferior	Anal fascia

THE NERVOUS SYSTEM.

Medulla Spinalis	Spinal Cord.
Fasciculus anterior proprius (Flechsig)	Anterior ground or basis bundle
Fasciculus lateralis proprius	Lateral ground bundle
Nucleus dorsalis	Clarke's column
Pars thoracalis	Dorsal part of spinal cord
Sulcus intermedius posterior	Paramedian furrow
Columnæ anteriores, etc.	Anterior grey column
Fasciculus cerebro-spinalis anterior	Direct pyramidal tract
Fasciculus cerebro-spinalis lateralis (pyramidalis)	Crossed pyramidal tract
Fasciculus cerebello-spinalis	Direct cerebellar tract
Fasciculus antero-lateralis superficialis	Gowers' tract

The Brain or **Encephalon** is divided into parts as follows :—

- **RHOMBENCEPHALON** = Myelencephalon (medulla) (after-brain) / Metencephalon (pons and cerebellum) (hind-brain) } Posterior primary vesicle.
- **CEREBRUM** = **MESENCEPHALON** (mid-brain, peduncles, corpora quadrigemina, etc.)—Middle primary vesicle.
  - **PROSENCEPHALON** (fore-brain)
    - **Diencephalon** = Thalamencephalon (inter-brain)
      - Thalamus (optic thalamus).
      - Metathalamus (geniculate bodies).
      - Epithalamus (pineal body).
    - Mammillary portion of hypothalamus (subthalamic region).
    - Posterior part of 3rd ventricle.
    - **Telencephalon**
      - Optic portion of hypothalamus (hypophysis).
      - Optic nerves.
      - Anterior part of 3rd ventricle.
    - Pallium (cortex cerebri).
    - Lateral ventricles.

Brain.

B.N.A. Terminology.	Old Terminology.
Rhombencephalon	
Eminentia medialis	Eminentia teres
Ala cinerea	Trigonum vagi
Ala acustica	Trigonum acusticum
Nucleus nervi abducentis	Nucleus of 6th nerve
Nuclei n. acustici	Auditory nucleus
Fasciculus longitudinalis medialis	Posterior longitudinal bundle
Corpus trapezoideum	Corpus trapezoides
Incisura cerebelli anterior	Semilunar notch (of cerebellum)
Incisura cerebelli posterior	Marsupial notch
Sulcus horizontalis cerebelli	Great horizontal fissure
Lobulus centralis	Lobus centralis
Folium vermis	Folium cacuminis
Tuber vermis	Tuber valvulæ
Lobulus quadrangularis	Quadrate lobule
Brachium conjunctivum cerebelli	Superior cerebellar peduncle
Lobulus semilunaris superior	Postero-superior lobule
Lobulus semilunaris inferior	Postero-inferior lobule
Cerebrum	
Pedunculus cerebri	Crus cerebri
Colliculus superior	Anterior corpus quadrigeminum
Colliculus inferior	Posterior corpus quadrigeminum
Aqueductus cerebri	Iter e tertio ad quartum ventriculum, or aqued. of Sylvius
Foramen interventriculare	Foramen of Monro
Hypothalamus	Subthalmic region
Sulcus hypothalamicus	Sulcus of Monro
Massa intermedia	Middle commissure
Fasciculus thalamo-mammillaris	Bundle of Vicq d'Azyr
Pars opercularis	Pars basilaris
Thalamus	Optic thalamus
Pallium	Cortex cerebri
Gyri transitivi	Annectant gyri
Fissura cerebri lateralis	Fissure of Sylvius
Gyrus temporalis superior	First temporal gyrus
Gyrus temporalis medius	Second temporal gyrus
Gyrus temporalis inferior	Third temporal gyrus
Sulcus centralis (Rolandi)	Fissure of Rolando
Sulcus temporalis superior	Parallel sulcus
Sulcus temporalis medius	Second temporal sulcus
Sulcus circularis	Limiting sulcus of Reil
Sulcus temporalis inferior	Occipito-temporal sulcus
Gyrus fusiformis	Occipito-temporal convolution
Sulcus interparietalis	Intraparietal sulcus
Sulcus corporis callosi	Callosal sulcus
Sulcus cinguli	Calloso-marginal fissure
Fissura hippocampi	Dentate fissure
Gyrus cinguli	Callosal convolution

B.N.A. Terminology.	Old Terminology.
Stria terminalis	Tænia semicircularis
Trigonum collaterale	Trigonum ventriculi
Hippocampus	Hippocampus major
Digitationes hippocampi	Pes hippocampi
Fascia dentata hippocampi	Gyrus dentatus
Columna fornicis	Anterior pillar of fornix
Septum pellucidum	Septum lucidum
Inferior cornu	Descending horn of lateral ventricle
Commissura hippocampi	Lyra
Nucleus lentiformis	Lenticular nucleus
Pars frontalis capsulæ internæ	Anterior limb (of internal capsule)
Pars occipitalis capsulæ internæ	Posterior limb (of internal capsule)
Radiatio occipito-thalamica	Optic radiation
Radiatio corporis callosi	Radiation of corpus callosum
Pars frontalis	Forceps minor
Pars occipitalis	Forceps major

Membranes of Brain.

Cisterna cerebello-medullaris	Cisterna magna
Cisterna interpeduncularis	Cisterna basalis
Granulationes arachnoideales	Pacchionian bodies
Tela chorioidea ventriculi tertii	Velum interpositum
Tela chorioidea ventriculi quarti	Tela choroidea inferior

Cerebral Nerves.

N. oculomotorius	Third nerve
N. trochlearis	Fourth nerve
N trigeminus	Fifth nerve
Ganglion semilunare (Gasseri)	Gasserian ganglion
N. naso-ciliaris	Nasal nerve
N. maxillaris	Superior maxillary nerve
N. meningeus (medius)	Recurrent meningeal nerve
N. zygomaticus	Temporo-malar nerve
Rami alveolares superiores posteriores	Posterior superior dental
Rami alveolares superiores medii	Middle superior dental
Rami alveolares superiores anteriores	Anterior superior dental
Ganglion spheno-palatinum	Meckel's ganglion
N. palatinus medius	External palatine nerve
N. mandibularis	Inferior maxillary nerve
Nervus spinosus	Recurrent nerve
N. alveolaris inferior	Inferior dental
N. abducens	Sixth nerve
N. facialis	Seventh nerve
N. intermedius	Pars intermedia of Wrisberg
N. acusticus	Eighth or auditory nerve

B.N.A. Terminology.	Old Terminology.
Ganglion superius	Jugular ganglion of 9th nerve
N. recurrens	Recurrent laryngeal nerve
Ganglion jugulare	Ganglion of root } of vagus
Ganglion nodosum	Ganglion of trunk } of vagus
Plexus œsophageus anterior }	Plexus gulæ
Plexus œsophageus posterior }	
Nervus accessorius	Spinal accessory
Ramus internus	Accessory portion of spinal accessory nerve
Ramus externus	Spinal portion

Spinal Nerves.

Rami posteriores	Posterior primary divisions
Rami anteriores	Anterior primary divisions
N. cutaneus colli	Superficial cervical nerve
Nn. supraclaviculares anteriores	Suprasternal nerves
Nn. supraclaviculares medii	Supraclavicular nerves
Nn. supraclaviculares posteriores	Supra-acromial nerves
N. dorsalis scapulæ	Nerve to the rhomboids
Nn. intercosto-brachiales	Intercosto-humeral nerve
N. thoracalis longus	Nerve of Bell
N. thoraco-dorsalis	Long subscapular nerve
N. cutaneus brachii medialis	Lesser internal cutaneous nerve
N. cutaneus brachii lateralis	Cutaneous branch of circumflex nerve
Fasciculus lateralis	Outer cord (of plexus)
Fasciculus medialis	Inner cord
N. cutaneus antibrachii lateralis	Cutaneous branch of musculo-cutaneous nerve
N. cutaneus antibrachii medialis	Internal cutaneous nerve
Ramus volaris	Anterior branch
Ramus ulnaris	Posterior branch
N. cutaneus antibrachii dorsalis	External cutaneous branch of musculo-spiral
N. axillaris	Circumflex nerve
N. interosseus volaris	Anterior interosseous
Ramus palmaris N. mediani	Palmar cutaneous branch of the median nerve
Nn. digitales volares proprii	Collateral palmar digital branches of median nerve
Ramus dorsalis manus	Dorsal cutaneous branch of ulnar nerve
Ramus cutaneus palmaris	Palmar cutaneous branch of ulnar nerve
N. radialis	Musculo-spiral nerve
N. cutaneus brachii posterior	Internal cutaneous branch of musculo-spiral nerve
N. cutaneus antibrachii dorsalis	External cutaneous branches of musculo-spiral nerve

B.N.A. Terminology.	Old Terminology.
N. radialis (*contd.*)—	Musculo-spiral nerve (*contd.*)—
Ramus superficialis	Radial nerve
N. interosseus dorsalis	Posterior interosseous nerve
Nn. digitales dorsales	Dorsal digital nerves
N. ilio-hypogastricus	Ilio-hypogastric nerve
Ramus cutaneus lateralis	Iliac branch of ilio-hypogastric nerve
Ramus cutaneus anterior	Hypogastric branch of ilio-hypogastric nerve
N. genito-femoralis	Genito-crural nerve
N. lumbo-inguinalis	Crural branch of genito-crural nerve
N. spermaticus externus	Genital branch of genito-crural nerve
N. cutaneus femoris lateralis	External cutaneous nerve
N. femoralis	Anterior crural nerve
N. saphenus	Long saphenous nerve
Ramus infrapatellaris	Patellar branch of long saphenous nerve
N. ischiadicus	Great sciatic nerve
N. peronæus communis	External popliteal nerve
Ramus anastomoticus peronæus	Nervus communicans fibularis
N. peronæus superficialis	Musculo-cutaneous nerve
N. peronæus profundus	Anterior tibial nerve
N. tibialis	Internal popliteal nerve
N. cutaneus suræ medialis	Nervus communicans tibialis
N. suralis	Short saphenous nerve
N. plantaris medialis	Internal plantar
N. plantaris lateralis	External plantar
N. pudendus	Pudic nerve

THE HEART AND BLOOD VESSELS.

Heart.

Atrium	Auricle
Auricula cordis	Auricular appendix
Incisura cordis	Notch at apex of heart
Trabeculæ carneæ	Columnæ carneæ
Tuberculum intervenosum	Intervenous tubercle of Lower
Sulcus longitudinalis anterior	Anterior interventricular groove
Sulcus coronarius	Auriculo-ventricular groove
Limbus fossæ ovalis	Annulus ovalis
Valvula venæ cavæ	Eustachian valve
Valvula sinus coronarii	Valve of Thebesius

Arteries.

B.N.A. Terminology.	Old Terminology.
Sinus aortæ	Sinuses of Valsalva
A. profunda linguæ	Ranine artery
A. maxillaris externa	Facial artery
A. alveolaris inferior	Inferior dental artery
Ramus meningeus accessorius	Small meningeal artery
A. buccinatoria	Buccal artery
A. alveolaris superior posterior	Posterior dental artery
Aa. alveolares superiores anteriores	Anterior superior dental arteries
Ramus carotico-tympanicus	Tympanic branch of int. carotid
A. chorioidea	Anterior choroidal artery
A. auditiva interna	Auditory artery
Rami ad pontem	Transverse arteries (branches of Basilar artery)
A. pericardiaco-phrenica	Arteria comes nervi phrenici
Rami intercostales (A. mammaria interna)	Anterior intercostal arteries
Truncus thyreo-cervicalis	Thyroid axis
A. transversa scapulæ	Suprascapular artery
A. intercostalis suprema	Superior intercostal
A. transversa colli	Transversalis colli
A. thoracalis suprema	Superior thoracic artery
A. thoraco-acromialis	Acromio-thoracic artery
A. thoracalis lateralis	Long thoracic artery
A. circumflexa scapulæ	Dorsalis scapulæ
A. profunda brachii	Superior profunda
A. collateralis radialis	Anterior branch of superior profunda
A. collateralis ulnaris superior	Inferior profunda
A. collateralis ulnaris inferior	Anastomotica magna
Ramus carpeus volaris	Anterior radial carpal
Ramus carpeus dorsalis	Posterior radial carpal
Aa. metacarpeæ dorsales	Dorsal interosseous arteries
A. volaris indicis radialis	Radialis indicis
Arcus volaris superficialis	Superficial palmar arch
Arcus volaris profundus	Deep palmar arch
A. interossea dorsalis	Posterior interosseous artery
A. interossea recurrens	Posterior interosseous recurrent artery
A. interossea volaris	Anterior interosseous artery
Ramus carpeus dorsalis	Posterior ulnar carpal
Ramus carpeus volaris	Anterior ulnar carpal
Aa. digitales volares communes	Palmar digital arteries
Aa. digitales volares propriæ	Collateral digital arteries
Arteriæ intestinales	Intestinal branches of sup. mesenteric
A. suprarenalis media	Middle capsular artery
A. hypogastrica	Internal iliac artery
A. umbilicalis	Obliterated hypogastric
A. pudenda interna	Internal pudic artery
A. epigastrica inferior	Deep epigastric artery

B.N.A. Terminology.	Old Terminology.
A. spermatica externa	Cremasteric artery
Aa. pudendæ externæ	Superficial and deep external pudic arteries
A. circumflexa femoris medialis	Internal circumflex artery
A. circumflexa femoris lateralis	External circumflex artery
A. genu suprema	Anastomotica magna
A. genu superior lateralis	Superior external articular artery
A. genu superior medialis	Superior internal articular artery
A. genu media	Azygos articular artery
A. genu inferior lateralis	Inferior external articular artery
A. genu inferior medialis	Inferior internal articular artery
A. malleolaris anterior lateralis	External malleolar artery
A. malleolaris anterior medialis	Internal malleolar artery
A. peronæa	Peroneal artery
Ramus perforans	Anterior peroneal artery
A. malleolaris posterior lateralis	Posterior peroneal artery
A. malleolaris posterior medialis	Internal malleolar artery
Rami calcanei laterales	External calcanean artery
Rami calcanei mediales	Internal calcanean artery
A. plantaris medialis	Internal plantar artery
A. plantaris lateralis	External plantar artery
Aa. metatarseæ plantares	Digital branches
Aa. digitales plantares	Collateral digital branches

Veins.

V. cordis magna	Great cardiac vein
V. obliqua atrii sinistri	Oblique vein of Marshall
Lig. venæ cavæ sinistræ	Vestigial fold of Marshall
Vv. cordis minimæ	Veins of Thebesius
Sinus transversus	Lateral sinus
Confluens sinuum	Torcular Herophili
Plexus basilaris	Basilar sinus
Sinus sagittalis superior	Superior longitudinal sinus
Sinus sagittalis inferior	Inferior longitudinal sinus
Spheno-parietal sinus	Sinus alæ parvæ
V. cerebri internæ	Veins of Galen
V. cerebri magna	Vena magna Galeni
V. terminalis	Vein of the corpus striatum
V. basalis	Basilar vein
V. transversa scapulæ	Suprascapular vein
V. thoraco-acromialis	Acromio-thoracic vein
Vv. transversæ colli	Transversalis colli veins
V. thoracalis lateralis	Long thoracic vein
V. azygos	Vena azygos major
V. hemiazygos	Vena azygos minor inferior
V. hemiazygos accessoria	Vena azygos minor superior
V. hypogastrica	Internal iliac vein
V. epigastrica inferior	Deep epigastric vein
V. saphena magna	Internal saphenous vein
V. saphena parva	External saphenous vein

Lymphatics.

B.N.A. Terminology.	Old Terminology.
Cisterna chyli	Receptaculum chyli

THE VISCERA.

Digestive Apparatus.

Arcus glosso-palatinus	Anterior pillar of fauces
Arcus pharyngo-palatinus	Posterior pillar of fauces
Gl. lingualis anterior	Gland of Nuhn
Ductus submaxillaris	Wharton's duct
Gl. parotis accessoria	Socia parotidis
Ductus parotideus (Stenonis)	Stenson's duct
Dentes præmolares	Bicuspid teeth
Dens serotinus	Wisdom tooth
Papillæ vallatæ	Circumvallate papillæ
Recessus pharyngeus	Lateral recess of pharynx
Tela submucosa	Pharyngeal aponeurosis
Plicæ circulares	Valvulæ conniventes
Gl. intestinales	Crypts of Lieberkuhn
Valvula coli	Ileo-cæcal valve
Columnæ rectales	Columns of Morgagni
Plicæ transversales recti	Valves of Houston
Valvula spiralis	Valves of Heister
Noduli lymphatici aggregati (Peyeri)	Peyer's patches
Intestinum jejunum	Jejunum
Intestinum ileum	Ileum
Noduli lymphatici lienales (Malpighii)	Malpighian corpuscles

Respiratory Apparatus.

Larynx	
Prominentia laryngea	Adam's apple
Incisura thyreoidea superior	Superior thyroid notch
M. ary-epiglotticus	Aryteno-epiglottidean muscle
M. vocalis	Internal thyro-arytenoid muscle
M. thyreo-epiglotticus	Thyro-epiglottidean muscle
Appendix ventriculi laryngis	Laryngeal sac
Plica vocalis	True vocal cord
Plica ventricularis	False vocal cord
Ligamentum ventriculare	Superior thyro-arytenoid ligament
Ligamentum vocale	Inferior thyro-arytenoid ligament
Glottis	Glottis vera
Rima vestibuli	Glottis spuria
Cartilago thyreoidea	Thyroid cartilage

B.N.A. Terminology.	Old Terminology.
Membrana hyo-thyreoidea	Thyro-hyoid membrane
Cartilago corniculata (Santorini)	Cartilage of Santorini
Tuberculum epiglotticum	Cushion of epiglottis
Pars intermembranacea (rimæ glottidis)	Glottis vocalis
Pars intercartilaginea (rimæ glottidis)	Glottis respiratoria
Conus elasticus (membranæ elasticæ larynges)	Crico-thyroid membrane
Glandula thyreoidea	Thyroid gland
Glomus caroticum	Intercarotid gland or body
Nose	
Concha nasalis suprema (Santorini)	Highest turbinate bone
Concha nasalis superior	Superior turbinate bone
Concha nasalis media	Middle turbinate bone
Concha nasalis inferior	Inferior turbinate bone

Urogenital Apparatus.

Corpuscula renis	Malpighian corpuscles
Paradidymis	Organ of Giraldés
Appendix testis	Hydatid of Morgagni (male)
Ductus deferens	Vas deferens
Gl. urethrales	Glands of Littré
Glandula bulbo-urethralis (Cowperi)	Cowper's gland
Folliculi oophori vesiculosi	Graafian follicles
Cumulus oophorus	Discus proligerus
Tuba uterina	Fallopian tube
Epoophoron	Parovarium
Appendices vesiculosi	Hydatids of Morgagni (female)
Ductus epoophori longitudinalis	Gärtner's duct
Orificium internum uteri	Internal os (of uterus)
Orificium externum	External os
Processus vaginalis	Canal of Nuck
Glandula magna vestibuli	Bartholin's gland

Peritoneum.

Bursa omentalis	Lesser peritoneal sac
Foramen epiploicum	Foramen of Winslow
Lig. phrenico-colicum	Costo-colic ligament
Excavatio recto-uterina (cavum Douglasi)	Pouch of Douglas
Lig. gastro-lienale	Gastro-splenic omentum

SENSE ORGANS.

The Eye.

Sclera	Sclerotic coat
Lamina elastica anterior (Bowmani)	Bowman's membrane

B.N.A. Terminology.	Old Terminology.
Lamina elastica posterior (Descemeti)	Descemet's membrane
Spatia anguli iridis	Spaces of Fontana
Angulus iridis	Irido-corneal junction
Zonula ciliaris	Zonule of Zinn
Septum orbitale	Palpebral ligament
Fascia bulbi	Capsule of Tenon
Commissura palpebrarum lateralis	External canthus
Commissura palpebrarum medialis	Internal canthus
Tarsus superior	Superior tarsal plate
Tarsus inferior	Inferior tarsal plate
Lig. palpebrale mediale	Internal tarsal ligament
Raphe palpebralis lateralis	External tarsal ligament
Tarsal glands	Meibomian glands

The Ear.

Canalis semicircularis lateralis	External semicircular canal
Ductus reuniens	Canalis reuniens
Ductus cochlearis	Membranous cochlea
Recessus sphericus	Fovea hemispherica
Recessus ellipticus	Fovea hemi-elliptica
Paries jugularis	Floor of tympanum
Paries labyrinthica	Inner wall
Fenestra vestibuli	Fenestra ovalis
Fenestra cochleæ	Fenestra rotunda
Paries mastoidea	Posterior wall
Antrum tympanicum	Mastoid antrum
Paries carotica	Anterior wall
Processus lateralis	Processus brevis (of malleus)
Processus anterior	Processus gracilis

MANUAL

OF

PRACTICAL ANATOMY.

THORAX.

THE dissection of the thorax is commenced on the *thirteenth* day[1] after the subject has been placed in the dissecting-room. By that time the upper limbs have been detached from the trunk.

In form, the thorax resembles a truncated cone. Anteriorly and posteriorly it is flattened; laterally it is full and rounded.

The cavity of the thorax is bounded—(1) *anteriorly*, by the sternum and costal cartilages; (2) *posteriorly*, by the twelve thoracic vertebræ and the intervening fibro-cartilages, together with the portions of the ribs which extend laterally from the vertebral column as far as the angles of the ribs; (3) *on each side* by the bodies of the twelve corresponding ribs, from their angles posteriorly to their anterior extremities anteriorly. The boundaries mentioned constitute the framework of the thorax, and can be studied on the skeleton, as well as upon the *part*, before the dissection is commenced.

The anterior wall of the thorax is so much shorter than the posterior wall that, during expiration, the upper margin of the sternum lies opposite the fibro-cartilage between the second and third thoracic vertebræ, and the lower end of the body of the sternum corresponds in level with the middle of the

[1] Saturdays and Sundays are not counted.

body of the ninth thoracic vertebra.[1] The bodies of the thoracic vertebræ project forwards into the cavity of the thorax, and greatly diminish its antero-posterior diameter in the median plane; but the backward sweep of the posterior portions of the ribs produces a deep hollow on each side of the vertebral column, for the reception of the most massive part of the corresponding lung (Fig. 5).

The superior aperture, or *inlet of the thorax*, is a narrow opening which is bounded by the first thoracic vertebra, the first pair of costal arches, and the manubrium sterni (Fig. 1). The plane of the superior aperture is very oblique; it slopes from the first thoracic vertebra forwards and downwards.

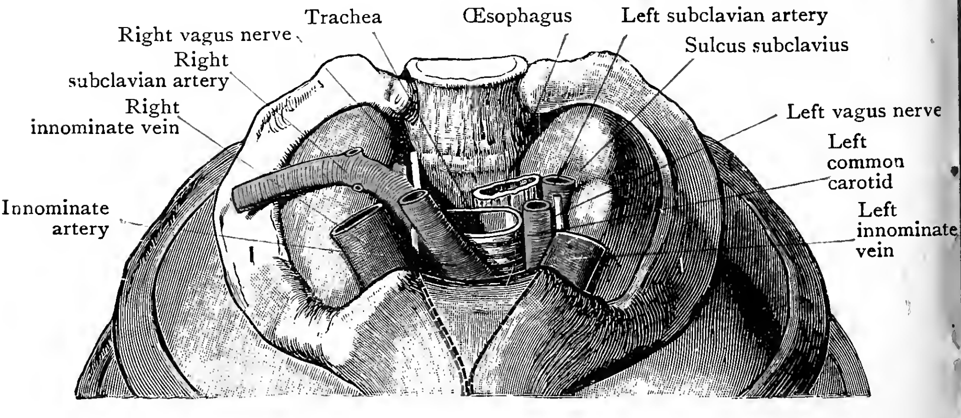

FIG. 1.—Cervical Domes of the Pleural Sacs, and parts in relation to them.

Through the aperture the apices of the lungs project upwards into the root of the neck, and, between them, the following structures either enter or leave the thorax:—the trachea, the œsophagus, the vagi, the phrenic nerves, the left recurrent nerve, the ganglionated sympathetic trunks, the thoracic duct, and the great arteries and veins which carry blood to and from the head and neck and the upper limbs.

The base or inferior aperture of the thorax is very wide, and is sometimes called the *outlet*. Anteriorly, it is bounded by the xiphoid process, and, posteriorly, by the twelfth thoracic vertebra. Between those points the lower margin of the thorax presents a curved outline. Starting from the sternum, it passes downwards, laterally, and backwards, as far as the

[1] This statement refers to average conditions. Not uncommonly the lower end of the body of the sternum is at the level of the tenth thoracic vertebra (Fig. 28).

tip of the eleventh costal cartilage; thence it proceeds upwards, backwards, and medially to the vertebral column. In the first part of its extent it is formed by the cartilages of the seventh, eighth, ninth, tenth and eleventh ribs, and in the second part by the lower border of the twelfth rib.

The lower margin of the thorax gives attachment to the diaphragm, a highly vaulted or dome-shaped musculo-tendinous partition, which intervenes between the cavity of the thorax above and that of the abdomen below. It forms a convex floor for the thorax, and a concave roof for the abdomen. By its upward projection it greatly diminishes the general vertical depth of the thoracic cavity (Figs. 9, 10, 11, 12).

As a result of this arrangement the peripheral margins of the inferior part of the thorax overlap the upper part of the abdomen, especially at the sides and behind.

But the diaphragm does not form an unbroken partition. It presents three large openings, by means of which structures pass to and from the thorax, viz.—(1) for the aorta, thoracic duct, and vena azygos; (2) for the œsophagus and vagi nerves; (3) for the inferior vena cava. Besides these there are other smaller apertures which will be mentioned later.

During life the movements of the thoracic wall produce alterations in the capacity of the thoracic cavity and play an essential part in the function of respiration. When inspiration takes place, that is when a "breath is taken," the sternum and the anterior parts of the ribs ascend and move forwards, with the result that the antero-posterior extent of the thoracic cavity is increased. At the same time, on account of the peculiarities of the articulations of the ribs, the lower borders of the majority of the ribs rotate outwards and the transverse diameter of the cavity is increased. The vertical extent of the thoracic cavity is increased by the contraction of the dome-shaped diaphragm. The central upper part of the dome which lies below the heart, and is tendinous, remains relatively stationary but the muscular peripheral parts contract. As they contract and pass from a more curved to a less curved position, they press down the contents of abdomen and distend the abdominal walls; consequently, as the floor of the thorax descends, the vertical extent of its cavity is increased.

As the cavity of the thorax is entirely enclosed, an increase of its extent tends to produce a vacuum in its interior, but

if the student will close his nose and mouth and then try to "take a breath" he will find that the diaphragm and the muscles which move the ribs are not competent to create a vacuum in the thorax, and nothing but an abortive inspiratory movement is possible. Under ordinary circumstances, however, as the walls of the thorax move in such a manner as to increase the size of the cavity, atmospheric pressure (15 lbs. to the square inch) forces air through the air passages into the distensible lungs, enlarging them as the thoracic cavity increases in size, so that they fully occupy the expanding space and no vacuum is formed.

In inspiration, therefore, the cavity of the thorax increases in extent, and the increased area is occupied mainly by air forced into the elastic lungs, but partly also by blood which flows into the great veins of the thorax. In expiration, when the contraction of the muscles which raise the sternum and ribs ceases, those bones return to their original positions and the antero-posterior and transverse extents of the thorax decrease. Simultaneously, the contraction of the diaphragm having ceased, the tonicity of the abdominal muscles forces the abdominal viscera back to their original positions, so restoring the convexity of the diaphragm and diminishing the vertical extent of the thoracic cavity. The combined effect of the descending sternum and ribs, the ascending abdominal viscera, forced upwards by the abdominal muscles, and the elasticity of the lungs, overcomes the atmospheric pressure and air is forced out of the lungs, or in other words the "breath goes out"—that is, *expiration* takes place.

The two parts of the respiratory movement, the thoracic part, produced by the movements of the ribs and sternum, and the abdominal part, due to the action of the abdominal muscles, may take place together, or independently, producing then, respectively, "thoracic respiration" and "abdominal respiration."

The student should study the movements carefully, both on himself and on his friends.

THORACIC WALL.

Two days at least should be devoted to the dissection of the thoracic wall.

In addition to the osseous and cartilaginous framework, the walls of the thorax are built up partly of muscles, and partly of membranes, and in connection with those there are numerous nerves and blood-vessels.

Muscles, . .	External intercostals. Internal intercostals. Transversi thoracis. Subcostals.
Membranes, . .	Anterior intercostal membranes. Posterior intercostal membranes. Pleural membranes (parietal parts).
Nerves and Arteries,	Intercostal nerves. Aortic intercostal arteries. Superior intercostal arteries. Internal mammary arteries.

As the thorax may be the first "part" that the student dissects it is important, before he commences work, that he should have a clear idea of the constitution of a typical spinal nerve. Every spinal nerve is attached to the spinal medulla (*spinal cord*) by two *roots*, an *anterior root* and a *posterior root* (Fig. 2). The posterior root has a swelling upon it which is called a ganglion; the anterior root is non-ganglionated. As the roots leave the vertebral canal through an intervertebral foramen they unite to form a *trunk*. Immediately after its exit from the intervertebral foramen the trunk divides into an *anterior ramus* and a *posterior ramus* (Fig. 2), of which the anterior ramus is, with few exceptions, much the larger. Each posterior ramus divides into a *medial branch* and a *lateral branch*. Each anterior ramus divides into a lateral branch and an anterior or ventral branch.

Every anterior root consists of nerve fibres which spring from nerve cells in the spinal medulla and pass to the muscle fibres of various muscles. They carry motor impulses to the muscles. Each posterior root consists of nerve fibres passing to and from the nerve cells of the ganglion of the posterior root. The posterior root fibres carry sensory impulses, such as cold, heat, pain, etc. The sensory impulses pass through the cells of the ganglion of the posterior root and then onwards to the spinal medulla.

The trunk of every spinal nerve, therefore, contains both *motor* or *efferent* and *sensory* or *afferent nerve fibres*, and the posterior and anterior rami into which it divides also contain both sets of fibres. The branches of the rami may contain

either both sets of fibres or only one or the other set. Eventually, however, the peripheral parts of the fibres conveying impulses from and those conveying impulses to the spinal medulla separate from one another. The fibres which convey impulses from the spinal medulla become the motor nerves which end in the muscle fibres, whilst the fibres which

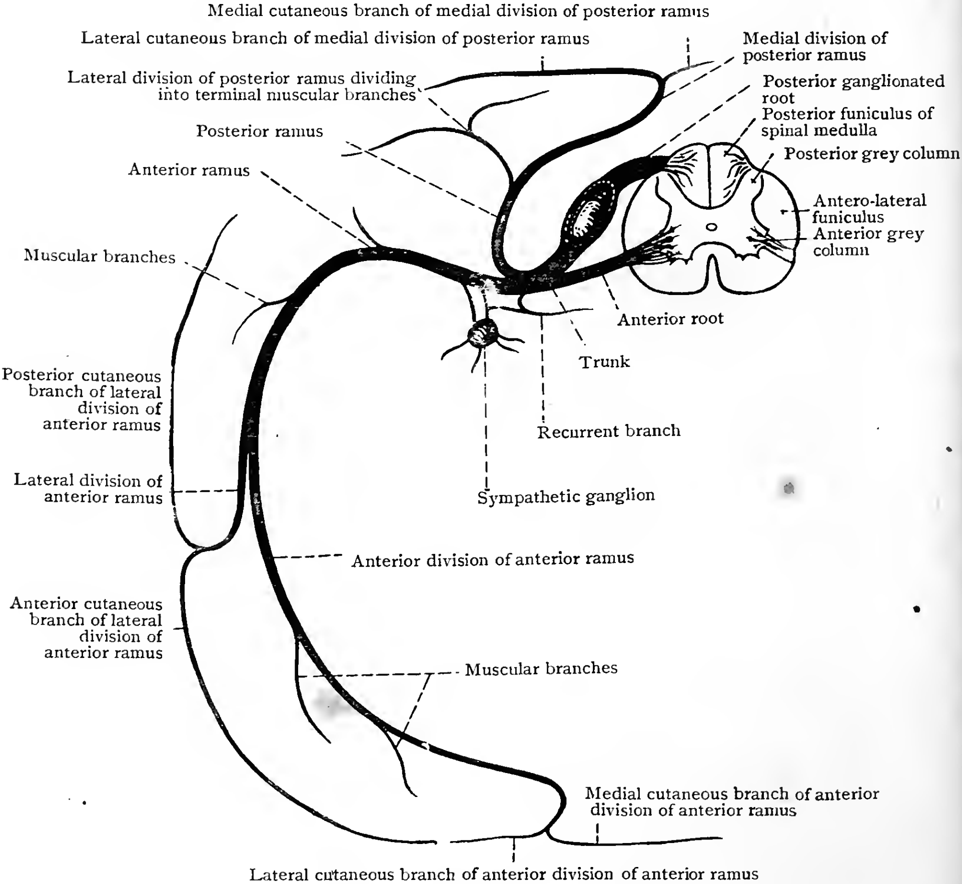

FIG. 2.—Diagram of the Spinal Nerve. Note that the medial division of the posterior ramus is represented as distributed to skin, whilst the lateral division terminates at a deeper level in muscle; in some situations the reverse condition occurs. The medial and lateral divisions of all posterior rami supply muscles.

convey sensory impulses only are the sensory nerve fibres. The sensory nerve fibres which convey sensory impulses from the skin are termed *cutaneous nerves.*

In the region of the thorax the branches which become

cutaneous are the medial branches of the posterior rami of the upper six thoracic nerves and the lateral branches of the posterior rami of the lower six; the lateral branches of the anterior rami and the anterior ends of the anterior branches.

The cutaneous branches of the posterior rami have already been removed by the dissectors of the extremities, but the dissector of the thorax will find remnants of the lateral and anterior branches of the anterior rami of the thoracic nerves on the lateral and anterior aspects of the wall of the thorax where they appear as lateral and anterior cutaneous nerves.

The upper six anterior cutaneous nerves on each side, the accompanying perforating branches of the internal mammary artery, and the lateral cutaneous nerves which have been left in position by the dissectors of the superior extremity and the abdomen, together with portions of certain muscles of the superior extremity and the abdominal wall which are still attached to the thoracic wall, must be identified and examined before the dissection of the thoracic wall is commenced.

The anterior cutaneous nerves and the perforating branches of the internal mammary artery will be found at the sternal ends of the intercostal spaces piercing the pectoralis major. The lateral cutaneous nerves lie along the mid-axillary line, where they appear between the digitations of the serratus anterior and the obliquus externus.

The remnants of muscles to be examined are, from before backwards, the *pectoralis major*, attached to the sternum and the cartilages of the upper six ribs; the *pectoralis minor*, attached to the sternal extremities of the bony parts of the third, fourth, and fifth ribs; and the *serratus anterior*, attached to the upper eight or nine ribs, along a line extending from the anterior to the posterior axillary margin. Towards the lower margin of the chest lie:—the *rectus abdominis*, attached to the xiphoid process and the cartilages of the fifth, sixth, and seventh ribs; the *obliquus externus*, attached to the lower eight ribs, interdigitating with the serratus anterior and the latissimus dorsi; and the *latissimus dorsi*, attached to the lowest three or four ribs.

Dissection.—**After their attachments have been verified remove the remnants of the muscles of the superior extremity**

and abdomen so as to lay bare the costal arches and the external intercostal muscles and membranes, but preserve the cutaneous nerves and the accompanying vessels. Clean the external intercostal muscles from behind forwards and note that in the upper spaces they are not prolonged between the costal cartilages, but terminate at or near the sternal ends of the bony parts of the ribs; the intervals between the muscles and the sternum are occupied by membranes, the *anterior intercostal membranes*,[1] which cover the anterior parts of the internal intercostal muscles.

Musculi et Membranæ Intercostales.—The intercostal muscles and membranes occupy the eleven intercostal spaces on each side. In each space there are two strata of muscular fibres—a superficial and a deep. The superficial layer of muscular fibres is called the *external intercostal muscle*, and the deep layer is called the *internal intercostal muscle.*

Musculi Intercostales Externi.—Numerous tendinous fibres are intermingled with the muscle fibres of the external intercostal muscles, and both the muscle fibres and the tendinous fibres are directed obliquely downwards and forwards from the lower border of the rib above to the upper border of the rib below. The muscles do not extend farther forwards, in the various spaces, than the region of union of the bony parts with the cartilaginous parts of the costal arches. In many cases, especially in the upper spaces, they do not reach so far. When the muscular fibres stop, the tendinous fibres are prolonged onwards to the sternum in the form of a membrane which is called the *anterior intercostal membrane.* The external intercostal muscles of the lower two spaces are exceptions to this rule. They extend forwards to the extremities of the spaces. Posteriorly, the muscles extend as far as the tubercles of the ribs, but that is a point which cannot be satisfactorily demonstrated at the present stage of dissection.

Dissection.—To bring the internal intercostal muscles into view it is necessary to reflect the external intercostal muscles, and also the anterior intercostal membranes. Divide two or more of the muscles and membranes along the lower borders of the spaces in which they lie, and throw each muscle and membrane upwards, but avoid injury to the intercostal vessels, which lie in the space between the external and internal intercostal muscles, and to the lateral branches of the intercostal nerve of the space.

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[1] The anterior intercostal membranes are sometimes called anterior intercostal ligaments, but such terminology is not justified either by their position or constitution.

Musculi Intercostales Interni.—The internal intercostal muscles, laid bare by the dissection described, will be seen to be similar in their constitution to the external muscles. The fibres, however, run in the opposite direction—viz., from above, obliquely downwards and backwards. Superiorly, each is attached to the inner surface of the upper rib, immediately above the costal groove; inferiorly, it is attached to the inner surface of the lower rib, close to the upper margin. The internal intercostal muscles are prolonged forwards to the sternum. Posteriorly, they extend to the angles of the ribs. The *posterior intercostal membranes* extend from the vertebral column to the posterior borders of the internal intercostals, where they become continuous with the fascial layer between the external and internal intercostal muscles. They will be seen when the thorax is opened.

If the internal oblique muscle of the abdomen has not been removed, the dissector should note that the anterior fibres of the lowest two internal intercostal muscles become continuous with the fibres of that muscle.

The lateral and anterior cutaneous branches of the intercostal nerves have already been found, but the main parts of the trunks of the nerves are concealed under cover of the lower borders of the ribs, and a little dissection is necessary to expose them and the intercostal arteries and veins which lie, at still higher levels, under cover of the ribs.

Dissection.—The intercostal nerves and vessels should be dissected in two or three spaces. If the arteries are not injected it may be difficult or impossible to display them in the anterior parts of the spaces, but the posterior parts of the intercostal branches of the aorta and of the subclavian artery will easily be found later, after the thorax is opened (see pp. 33-35). First find the lateral cutaneous branch of an intercostal nerve, preferably that of the third, fourth, or fifth intercostal space. It will serve as a guide to the trunk of the nerve. Follow the lateral cutaneous branch to the lower border of the rib which bounds the space above, then take the bone forceps and cut away the lower border of the rib until the origin of the lateral cutaneous branch from the trunk of the nerve is found. When the trunk of the intercostal nerve has been secured, follow it backwards as far as possible, removing the lower part of the rib which covers it, and, at the same time, clean the intercostal artery and vein which lie above it, if they can be found. Next follow the trunk of the nerve forwards beyond the origin of the lateral cutaneous branch. About midway between the vertebral column and the sternum it leaves the artery and enters the substance of the internal intercostal muscle, whilst the artery continues forwards on the internal intercostal muscle to anastomose with an intercostal branch of the internal mammary

artery. Follow the nerve through the internal intercostal muscle. It reaches the deep surface of the muscle at the junction of the cartilage with the bone of the rib and then passes onwards either between the internal intercostal and the pleura or between the internal intercostal and the transversus thoracis muscle to the internal mammary artery, which descends behind the costal cartilages about 13 mm. (half an inch) from the margin of the sternum. Follow the nerve across the front of the internal mammary artery and note that it terminates as an anterior cutaneous nerve. As the intercostal nerve is cleaned small branches will be found passing from it to supply the intercostal

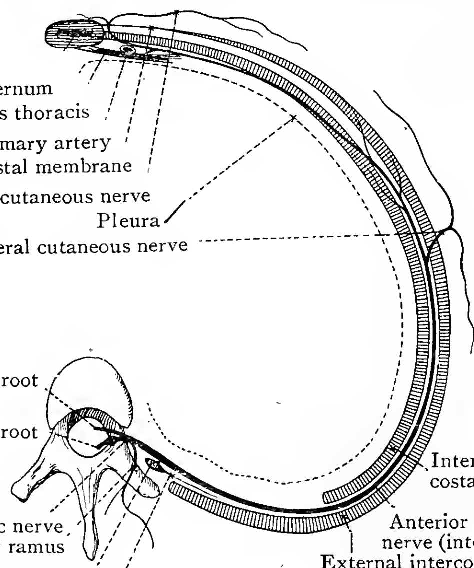

FIG. 3.—Diagram of one of the Upper Intercostal Nerves.

muscles. If one of the lower six intercostal nerves is followed it will be found to pass out of the anterior part of the intercostal space, into the abdominal wall, where it will be traced by the dissector of the abdomen.

Nervi Intercostales.—The intercostal nerves are the anterior rami of the upper eleven thoracic nerves on each side. Each nerve gives a white branch to and receives a grey branch from a ganglion of the sympathetic trunk, and then enters the corresponding intercostal space. At the angle of the ribs it passes into the interval between the external and internal intercostal muscles and runs forwards, between the muscles, to about the mid-axillary line. Then it begins to pass obliquely through the internal intercostal muscle, reaching the internal surface of the muscle at the

junction of the bone with the cartilage of the rib; from that point it continues towards the median plane, lying in the cases of the first two nerves between the internal intercostal muscle and the pleura, and in the cases of the third, fourth, and fifth, between the internal intercostal muscle and the transversus thoracis. About 13 mm. from the sternum it crosses in front of the internal mammary vessels; then, it turns forwards, and after piercing the internal intercostal muscle, the anterior intercostal membrane, the pectoralis major muscle, and the deep fascia, it enters the superficial fascia of the thorax as an anterior cutaneous nerve.

The above description holds good for the upper five nerves only; after the lower six nerves have reached the deep surfaces of the corresponding internal intercostal muscles they leave the anterior ends of the intercostal spaces and enter the wall of the abdomen. As they leave the thoracic wall the upper four of the six pass posterior to the upturned costal cartilages, and all six pass between interdigitating slips of the diaphragm and the transversus abdominis. Then they continue towards the median plane between the transversus abdominis and the obliquus internus, enter the sheath of the rectus abdominis, turn forwards, and, after piercing the rectus abdominis, the anterior wall of its sheath, and the deep fascia, they enter the superficial fascia as anterior cutaneous nerves of the abdomen.

The dissector of the thorax traces the lower intercostal nerves only as far as the anterior ends of the intercostal spaces. The dissector of the abdomen has displayed them in the wall of the abdomen.

Whilst the intercostal nerves are between the intercostal muscles each gives off branches to the muscles between which it lies, and a lateral cutaneous branch. The *lateral cutaneous branch* pierces the external intercostal muscle and then passes, according to its position, either between digitations of the serratus anterior or external oblique muscles and divides into anterior and posterior branches which are distributed to the skin. The first intercostal nerve does not give a lateral cutaneous branch. Nor does it become cutaneous at its termination. The lateral cutaneous branch of the second is distributed to the arm as the *intercosto-brachial* nerve. The lateral cutaneous branches of the lower intercostal nerves supply muscular twigs to the digitations of the external oblique

muscle of the abdomen. The anterior continuations of several of the intercostal nerves give additional muscular twigs to the adjacent muscles. The fourth, fifth, and sixth supply the transversus thoracis, and the lower six supply the internal oblique, the transversus abdominis, and the rectus abdominis muscles.

Dissection.—If the dissector has not been successful in displaying the intercostal vessels in the spaces in which he has dissected the nerves an attempt should be made to dissect out the vessels in a fresh space, but a satisfactory demonstration of the vessels in the anterior parts of the spaces will not be possible unless the subject has been well injected.

Arteriæ Intercostales.—In each intercostal space *one* artery is found passing *dorso-ventrally*; and in each of the upper nine intercostal spaces *two* anterior intercostal arteries run *ventro-dorsally.*

In the uppermost two spaces the vessels which run dorso-ventrally are derived from the *superior intercostal* division of the costo-cervical branch of the subclavian artery; in the lower nine spaces they spring directly from the aorta, and are called the *aortic intercostal arteries.*

The *anterior intercostal arteries* of the upper six spaces are branches of the internal mammary artery, whilst those of the seventh, eighth, and ninth spaces arise from the musculo-phrenic artery. There are no anterior intercostal arteries in the last two spaces.

The intercostal vessels are distributed, for the most part, between the two muscular strata. From the angles of the ribs onwards to a point midway between the vertebral column and sternum, the *aortic intercostal arteries* lie under shelter of the lower margins of the ribs which bound the spaces superiorly, at a higher level than the corresponding nerves and below the accompanying vein. Midway between the vertebral column and the sternum each aortic intercostal artery divides into two branches, which pass forwards in relation to the upper and lower margins of the intercostal space, and either the trunk or the upper branch gives off a twig which accompanies the lateral cutaneous nerve. The lower two aortic intercostal arteries are carried onwards into the abdominal wall. The branches of the *superior intercostal artery* are disposed in a manner similar to the upper aortic intercostal vessels.

The *anterior intercostal arteries* are two in number for each space, except the last two. At their origins they lie under cover of the internal intercostal muscles, and they run laterally in relation to the upper and lower margins of the ribs bounding the spaces. After a short course they pierce the internal intercostal muscles, and end by anastomosing with branches of the aortic and superior intercostal arteries.

The *anterior intercostal veins* accompany the corresponding arteries; the lower ones end in the musculo-phrenic vein, and the upper in the venæ comites of the internal mammary artery.

The veins which accompany the aortic intercostal arteries and the branches of the superior intercostal artery will be traced to their terminations after the thorax has been opened (see p. 33).

Dissection.—The dissector should next proceed to remove the intercostal muscles and membranes from all the intercostal spaces. This dissection must be done with great care, for immediately subjacent to the internal intercostals and the ribs is the delicate pleural membrane which lines the inner surface of the chest wall. The membrane must not be injured or detached from the deep surfaces of the ribs during this stage of the dissection. As the internal intercostal muscles are removed, the anterior perforating branches of the internal mammary and musculo-phrenic arteries, and the anterior cutaneous nerves, must be preserved.

When the muscles are removed the internal mammary artery, with its two accompanying veins, will be seen behind the costal cartilages, about half an inch from the side of the sternum (Figs. 20, 27). Clean those vessels in the intervals between the cartilages, and note the small *sternal lymph glands* which lie beside them. Each internal mammary artery ends by dividing into superior epigastric and musculo-phrenic terminal branches in the interval between the sixth and seventh rib cartilages. Most likely that space will be so narrow that a view of the bifurcation cannot be obtained. If that is the case, pare away the edges of the cartilages or, if necessary, remove a portion of the sixth cartilage completely. The muscle posterior to the internal mammary artery is the transversus thoracis (O.T. triangularis sterni). Endeavour to define its slips in the intervals between the costal cartilages.

The dissector should note, as an important practical point, that, towards the lower and anterior parts of the thorax, the pleural sac is not prolonged downwards to the lowest limit of the recess between the diaphragm and the costal arches. Indeed, in the mid-axillary line, and along the costal arch on each side, it will be found to fall considerably short of that limit. Consequently, when the internal intercostal muscles are removed from the anterior parts of the lower intercostal spaces, the dissector will come down directly upon the diaphragm (Fig. 9).

The fibres of the diaphragm, in the region in question, correspond somewhat in their direction with those of the internal intercostal muscles, and it is no uncommon occurrence for the student to remove them, and thus expose the peritoneum, under the impression that he has laid bare the pleura. When the dissection of the lower intercostal spaces is properly executed a strong fascia will be exposed as the internal intercostal muscles are removed.

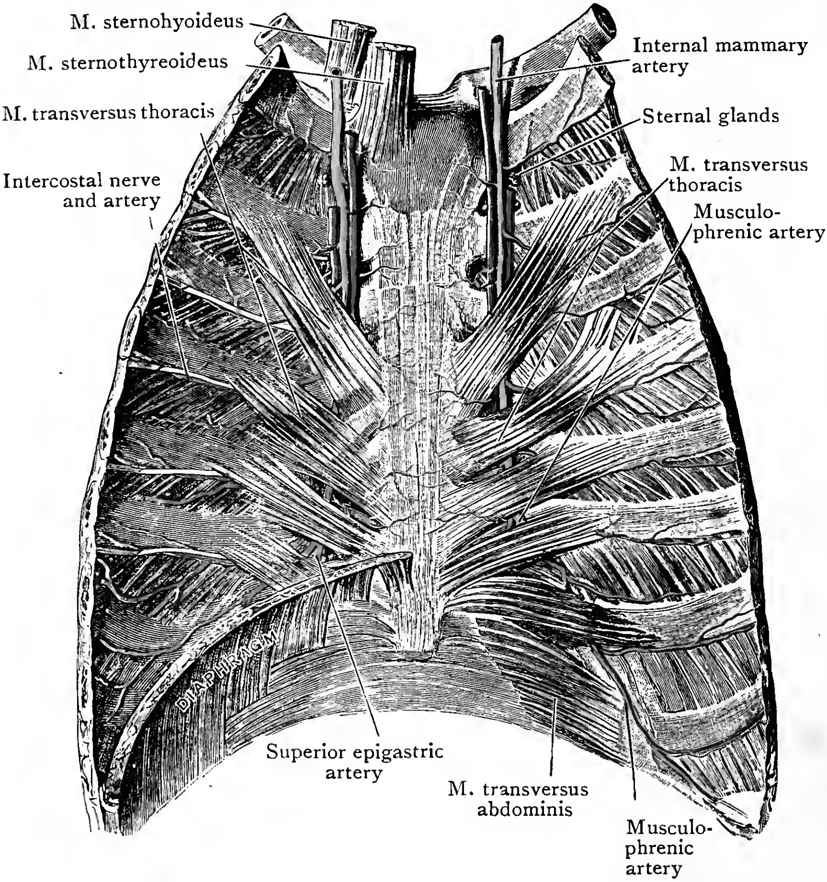

FIG. 4.—Dissection of the posterior surface of the Anterior Wall of the Thorax.

It passes from the surface of the diaphragm to the costal pleura and holds the latter in position. Preserve it for further examination.

Arteria Mammaria Interna.—Each internal mammary artery arises, in the root of the neck, from the first part of the corresponding subclavian artery. It enters the thorax by passing downwards, posterior to the sternal end of the clavicle and the cartilage of the first rib, and it descends to the interval

between the sixth and seventh costal cartilages, where it ends by dividing into the *superior epigastric* and the *musculo-phrenic branches* (Figs. 4, 27).

Placed anterior to the internal mammary artery are the upper six costal cartilages, with the intervening internal intercostal muscles and anterior intercostal membranes. The intercostal nerves cross anterior to it before they turn forwards to gain the surface. Posterior to the upper part of the artery is the pleura; and the transversus thoracis intervenes between the lower part of the artery and the pleural sac.

The branches of the internal mammary artery are two terminal and a large number of small collateral twigs—

1. The anterior intercostal, 2. The perforating,	to the thoracic parietes.
3. The pericardiaco-phrenic, 4. Mediastinal and thymic,	to parts in the interior of the thorax.
5. Superior epigastric, 6. Musculo-phrenic,	the terminal branches.

The *anterior intercostal arteries* are supplied to the upper six intercostal intervals, and have been dissected already (p. 12). Two are given to each space: each pair may arise by a common trunk from the internal mammary stem.

The *perforating arteries* accompany the anterior cutaneous nerves. They reach the surface by piercing the internal intercostal muscles, the anterior intercostal membranes, and the pectoralis major muscle. One, or perhaps two, are given off in each intercostal space. In the female, those of the second, third, and fourth spaces attain a special importance, inasmuch as they are important arteries of supply to the mammary gland.

The *superior epigastric artery* passes between the sternal and costal origins of the diaphragm and enters the sheath of the rectus muscle of the abdominal wall.

The *musculo-phrenic artery* turns laterally and downwards, along the costal origin of the diaphragm and behind the rib-cartilages. Opposite the eighth costal cartilage it pierces the diaphragm and terminates on its abdominal surface. It gives off the *anterior intercostal arteries* to the seventh, eighth, and ninth intercostal spaces.

Vena Mammaria Interna.—Each internal mammary artery is accompanied in the greater part of its course by two venæ comites. At the upper part of the thorax the venæ comites

of each artery end in a single internal mammary vein, which joins the corresponding innominate vein in the superior mediastinum. The terminations of the internal mammary veins will be seen when the contents of the superior mediastinum are dissected (see p. 66 and Figs. 4, 27).

Musculus Transversus Thoracis (O.T. **Triangularis Sterni**).—The transversus thoracis is a thin muscular layer placed on the deep surface of the sternum and costal cartilages. It arises from the posterior surface of the xiphoid process, the lower part of the body of the sternum, and from the medial ends of the fifth, sixth, and seventh costal cartilages, and it is continuous below with the transversus abdominis. Its fibres radiate in an upward and lateral direction, in the form of five slips, which are inserted into the deep surfaces and lower borders of the second, third, fourth, fifth, and sixth costal cartilages, close to their junction with the ribs (Fig. 4). It is supplied by the fourth, fifth, and sixth intercostal nerves, and probably facilitates expiration by assisting to depress the anterior parts of the ribs. It is supplied by the intercostal nerves.

In many cases the muscle is feebly developed, and does not show such wide connections. Upon its anterior aspect are placed the internal mammary artery and some of the intercostal nerves.

It is only a partial view of the muscle which is obtained in the present dissection, but it is not advisable to remove the costal cartilages to expose it further, as this would materially interfere with the subsequent display of the relations of other more important structures.

THORACIC CAVITY.

Before the dissection of the interior of the thorax is commenced it is necessary that the dissectors should have some general knowledge of the cavity and its contents. The shape and the boundaries have been studied already (p. 1), and it must now be understood that the cavity is divided into two lateral parts, right and left, by a median septum called *the mediastinum*, which extends from the sternum anteriorly to the vertebral column posteriorly, and from the upper aperture of the thorax above to the diaphragm below.

In the mediastinal septum lie the heart, enveloped in a fibro-serous sac called the pericardium; the great vessels passing to and from the heart, *i.e.* the pulmonary artery and veins, the aorta, and the vena cava superior; the œsophagus; the trachea and the commencements of the bronchi; the thoracic duct; the azygos, hemiazygos and accessory hemi-azygos veins; the vagi and phrenic nerves; numerous lymph glands; all the structures mentioned are embedded in the areolar tissue of the septum which ensheaths them and binds them together whilst, at the same time, on account of its elasticity it allows the heart and vessels to dilate and contract. In addition there are the remains of the thymus gland which vary considerably in size at different periods of life. For convenience of description the mediastinum is divided into a *superior* and an *inferior portion*, by an imaginary plane which passes from the lower border of the manubrium sterni anteriorly, to the lower border of the fourth thoracic vertebra posteriorly; and the inferior mediastinum is subdivided into anterior, middle, and posterior portions. The *anterior mediastinum* is the part anterior to the pericardium; the *posterior mediastinum* is the part posterior to the pericardium; whilst the pericardium and the heart, with the great vessels, and portions of the phrenic nerves, with their accompanying vessels, lie in the *middle mediastinum* (Figs. 20, 21, pp. 50, 51).

The lateral portions of the thoracic cavity are known as the pleural spaces, though no such spaces exist, for each so-called space contains and is completely filled by the corresponding lung, which is surrounded by an invaginated serous membrane called the pleural sac. There are therefore two pleural sacs, and each is so disposed that it not only lines the chamber in which the lung lies, but is also reflected over the surface of the lung, so as to give it an external covering which is intimately connected with the pulmonary substance. Consequently, the wall of each pleural sac is separable into two portions, an investing or visceral part which covers the surface of the lung, and a lining or parietal part which clothes the inner surfaces of the boundary of each lateral part of the thoracic cavity. It must be clearly understood, however, that the two terms are applied merely to indicate different portions of a continuous membrane.

Each lung lies free in the pleural space, except along its

medial surface, where it is attached to the heart by the pulmonary vessels ; to the corresponding bronchial tube ; and, by a fold of pleura, to the side of the pericardium.

The dissection which has already been made shows the pleura lining the deep surfaces of the costal arches and the internal intercostal muscles. That part is called the *costal pleura*, and it is part of the *parietal pleura*. The student must understand that the term costal pleura is applied only to that part of the parietal pleura which lines the costal part of the thoracic wall ; the part which covers the mediastinum

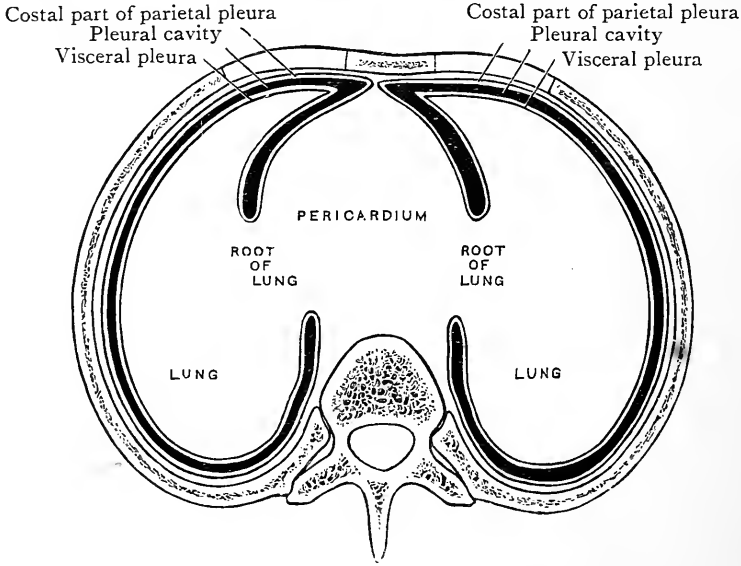

FIG. 5.—Diagrammatic representation of a cross section through the Thorax.

is called *mediastinal pleura*, the part which covers the upper surface of the diaphragm is the *diaphragmatic pleura*, and the part which projects into the root of the neck is spoken of as the *apical* or *cervical pleura*. Before the costal pleura can be more fully investigated, and before the remaining parts of the pleuræ and the lungs can be examined, further dissection is necessary.

Dissection.—The pleural membrane previously exposed by the removal of the contents of the intercostal spaces must now be carefully separated from the inner surfaces of the ribs by gentle pressure of the fingers. The separation should be carried anteriorly to the junction of the ribs with their cartilages and posteriorly as far as possible. When that has been done, the

ribs, from the second to the eighth inclusive, must be divided, with bone forceps, at their junctions with their cartilages, and, at the same time, any fibres of the transversus thoracis which may be attached to them must be cut. *The first and the ninth ribs and those below the ninth must not be interfered with.* Afterwards the ribs, from the second to the eighth inclusive, must be divided as near their vertebral ends as possible and the separated portions removed. After the separated parts of the ribs are detached, remove any sharp spicules of bone from the cut ends of the remaining portions.

The outer surface of the costal part of the parietal pleura will then be exposed in the area from which the ribs have been removed, and the dissector should notice that it has the appearance of a fibrous membrane with a rough surface, the roughness being due to fragments of the connective tissue (endothoracic fascia) which connect it with the adjacent parts.

After the dissector has examined the outer surface of the pleura, he should divide the membrane by a vertical incision about midway between the anterior and posterior borders of the area exposed. At each end of the vertical incision a transverse incision must be made. One of the two flaps, so formed, must be thrown forwards, and the other backwards. The pleural sac will then be opened and the lateral surface of the lung, covered with the adherent visceral portion of the pleura, will be exposed.

The cavity of the sac and its relations to the mediastinal septum, to the diaphragm, and to the root of the neck, can now be explored with the fingers; and the borders, surfaces, and the root of the lung can be examined.

If the lungs are healthy and are not hardened with formalin they will shrink to one third of their original bulk as soon as the pleural sacs are opened.

Pleuræ.—There are two pleural sacs, a right and a left. They are serous sacs, and are therefore closed. After opening into the interior, the dissector should notice the difference between the rough outer surface of the wall of the sac and its smooth and glistening inner surface, and in order that he may thoroughly understand the relationship of the wall of the sac to the lung, and to the mediastinum and the wall of the thoracic cavity, he should follow the wall of the sac, with his fingers, at three different levels—(1) at the level of the third intercostal space, (2) at the level of the fifth costal cartilage, and (3) at the level of the manubrium sterni. He must trace the wall of the sac in the vertical plane also.

Commencing at the level of the third intercostal space, he should place his fingers on the surface of the lung and follow it forwards and medially until, behind the sternum, he reaches the sharp, anterior border, which should be pulled laterally; then, turning from the lung to the parietal pleura, he should place his fingers on the inner surface of the anterior flap and

follow it medially. He will find, at a certain point posterior to the sternum, and to the left of the median plane, that his fingers cease to pass towards the opposite side but are carried backwards on the mediastinal part of the parietal pleura, along the lateral boundary of the mediastinum, until they come to the big blood-vessels and the air tube of the lung, which collectively form its root. Along the front of the vessels his fingers will now pass laterally, following the reflection of the pleura on the front of the vessels, to the medial surface of the lung, and then anteriorly to its anterior border. Round the anterior border they will arrive at the lateral surface of the lung; along that surface they will pass to the posterior border and thence forwards along the posterior part of the medial surface to the posterior surface of the root, where they will feel, distinctly, the hard outline of the bronchus. Following the posterior surface of the root medially, they will reach the posterior part of the lateral boundary of the mediastinum, along which they will pass backwards to the vertebral column, and thence laterally along the posterior parts of the ribs, and finally forwards along the inner surface of the posterior flap to its anterior margin.

If the dissector has followed the instructions given above he cannot have failed to recognise that the pleural sac is invaginated by the lung, which in its growth laterally from the mediastinal septum has invaginated and expanded a part of the medial wall of the sac. The dissector should now examine a transverse section of a hardened thorax, or, if that is not available, the diagram on p. 18. The study of either will convince him that the lung, carrying the invaginated part of the wall of the pleural sac on its surface, has expanded until it has practically obliterated the cavity of the sac; and he will understand that the invaginated pleura on the surface of the lung, which is called the *visceral pleura*, is everywhere in close apposition with the non-invaginated portion, which is termed the *parietal pleura*; all that intervenes between the two portions, in ordinary circumstances during life, is a thin stratum of fluid, sufficient to lubricate the surfaces and prevent friction during the movements of the lung and the chest wall.

After the dissector has grasped the facts noted above he should follow the inner surface of the pleura in the transverse plane at the level of the fifth costal cartilage, that is, below

the level of the root of the lung. At that level he will find that the parietal pleura covering the lateral surface of the mediastinal septum is connected with the visceral pleura on the medial surface of the lung by a thin fold called the pulmonary ligament (O.T. ligamentum latum pulmonis). The ligament consists of an anterior and a posterior layer, which correspond, respectively, with the layers on the front and the back of the root of the lung, but they are in contact with each other at the level of the fifth rib, on account of the absence of the great blood-vessels and air tube of the lung. The *pulmonary ligament* extends from the mediastinum to the medial surface of the lung, and from the root of the lung above, to within a short distance from the diaphragm below. Its medial, lateral, and upper borders are attached respectively to the mediastinal septum, the lung, and the lower border of the lung root, and are continuous with the pleura covering each, but its lower border is free. When the dissector has satisfied himself regarding the nature and the attachments of the pulmonary ligament, he should trace the pleura in the horizontal plane at the level of the manubrium sterni, that is, above the level of the root of the lung. There he will find that the medial wall of the sac is not reflected on to the lung, but that it passes backwards along the surface of the mediastinal septum, from the sternum anteriorly to the vertebral column posteriorly, and thence laterally and forwards to the sternum, in an unbroken circle. In the same way he will be able to trace the visceral pleura in a similar but smaller unbroken circle around the upper part of the lung.

Having traced the pleura in three horizontal planes the dissector must next trace it in the vertical plane, first around the lung, and then around the wall of the thorax. Commencing with the lung, the fingers should be passed along the anterior border to the apex, thence, down the thick posterior border, to the base, and forwards, across the concave base, to the anterior border. By doing this the dissector will again demonstrate to himself the fact that the lung is ensheathed in visceral pleura. Next, placing his fingers on the inner surface of the parietal pleura behind the costal cartilages, he should carry them upwards towards the head, and he will find that they pass upwards into the root of the neck for a distance of from one to two inches above the level of the anterior part of the first rib, but, on account of the oblique position of the rib, only to the level of

its neck posteriorly. The apex of the sac, therefore, lies in the root of the neck, and by carefully palpating its inner surface the dissector will be able to distinguish the subclavian artery, which passes across its anterior surface below the highest point, and, possibly, he may be able to locate the internal mammary and costo-cervical arteries (O.T. superior intercostal) (Fig. 6). The first descends from the subclavian trunk anterior to the apex of the sac, and the second passes first

FIG. 6.—Structures in relation with the apex of the pleural sac, seen from below.

upwards to the apex and then backwards above it. After the dissector has examined the position and relations of the apex of the sac he should follow its posterior wall downwards, just lateral to the line of the vertebral column. If he is dealing with a subject in good condition, he will find that he can pass his fingers downwards to the lower border of the twelfth rib, where they will be carried forwards on to the diaphragm and over its surface to the anterior wall of the thorax. If the dissector carries out the examination of the

pleural sac in a thorough manner, and if he has appreciated the significance of the arrangements found at different levels, he will have repeatedly convinced himself that the lung, carrying the blood-vessels and air tube with it, has during its development, invaginated a portion of the lower part of the medial wall of the pleural sac, and has then expanded anteriorly, posteriorly, upwards and, to a certain extent, downwards, beyond the margins of the aperture of invagination; the position of the aperture being indicated by the root of the lung and the line of attachment of the pulmonary ligament. The portion of the wall of the pleura which is invaginated by the lung is represented by: (1) the visceral pleura, (2) the layers covering the root of the lung, and (3) the pulmonary ligament.

Before each lung is removed the dissectors should note that its anterior margin does not extend so far forwards, and the inferior margin does not extend so far downwards, as the corresponding part of the pleura. The portions of the pleura unoccupied by the lung are called the pleural sinuses. The sinus along the anterior margin of the pleura is the *costo-mediastinal sinus*, and that along the lower margin, the *phrenico-costal sinus*. The walls of the sinuses are separated by a thin layer of pleural fluid, and the margins of the lungs enter the sinuses during inspiration and recede from them during expiration.

In the event of the lungs not having been hardened *in situ* by formalin injection, the dissectors may, with the consent of the dissectors of the head and neck, introduce the nozzle of the bellows into the cervical part of the trachea and inflate the lungs with air. A truer conception of the size and the form of the organs will then be obtained, and a demonstration will be afforded of their high elasticity, and of their connection with the wind-pipe.

Dissection.—After the dissector has completed the general examination of the walls of the pleural sac, he should pull the anterior margin of a lung laterally to expose its medial surface, the front of the root and the front of the pulmonary ligament; then he should divide the root and the pulmonary ligament, from above downwards, close to the medial surface of the lung. The lung, thus set free, is to be removed from the thorax, wrapped in a cloth damped with preservative solution, and placed aside for future study. The opposite lung must be removed in a similar manner, and then the margins of the pleural sacs must be examined and their positions, relative to the chest wall, must be noted.

When both lungs have been removed the dissector should

introduce one hand into each pleura, and placing an index finger in each apex, he should note that the apex is situated about one inch above the medial third of the clavicle, a fact which he can demonstrate with the aid of his partner on the opposite side, who should hold two macerated clavicles in their proper positions. The apices of opposite sides, therefore, are some distance apart, and are separated from each other by the structures occupying the median part of the neck; *i.e.* the trachea, the œsophagus, and the great vessels passing to and from the head. As the anterior margins of the pleuræ are traced downwards from the apices they will be found to converge, passing behind the sterno-clavicular joints and coming into apposition at the lower border of the manubrium, immediately to the left of the median plane. Traced further downwards, the anterior margins remain in apposition, the right often overlapping the left and both inclining slightly to the left, as far as the level of the fourth costal cartilages. From the fourth cartilage the anterior margin of the right sac continues to descend, still with a slight inclination to the left, till it reaches the xiphoid process, where it becomes continuous with the inferior margin. The inferior margin turns laterally, passing behind the xiphoid process and the cartilage of the seventh rib; it then crosses the junction of the bone and cartilage of the eighth rib, and reaches the level of the tenth rib in the mid-axillary line; turning posteriorly, it crosses the eleventh and twelfth

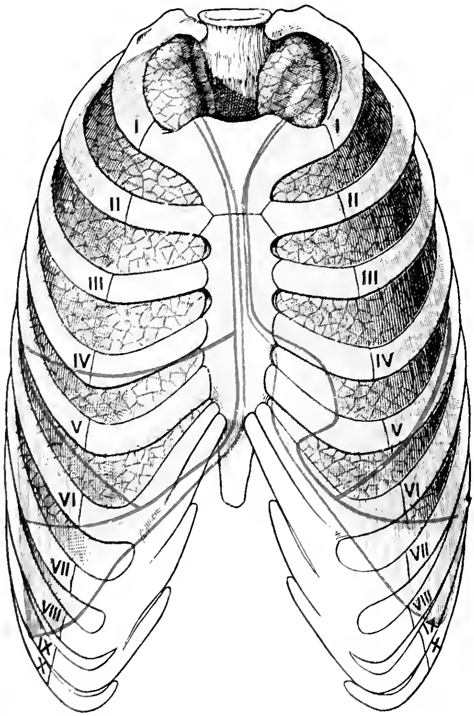

FIG. 7.—Diagram to show the relation of the lungs and the pleural sacs to the anterior thoracic wall. The lungs are depicted in red, and the pleural sacs in blue.

ribs, and just below the middle of the twelfth it becomes continuous with the posterior margin, which ascends along the line of the angles of the ribs to the apex. On the left side, at the level of the fourth costal cartilage, the anterior margin of the left pleura turns away from the median plane, for a variable distance, passing behind the fifth costal cartilage at

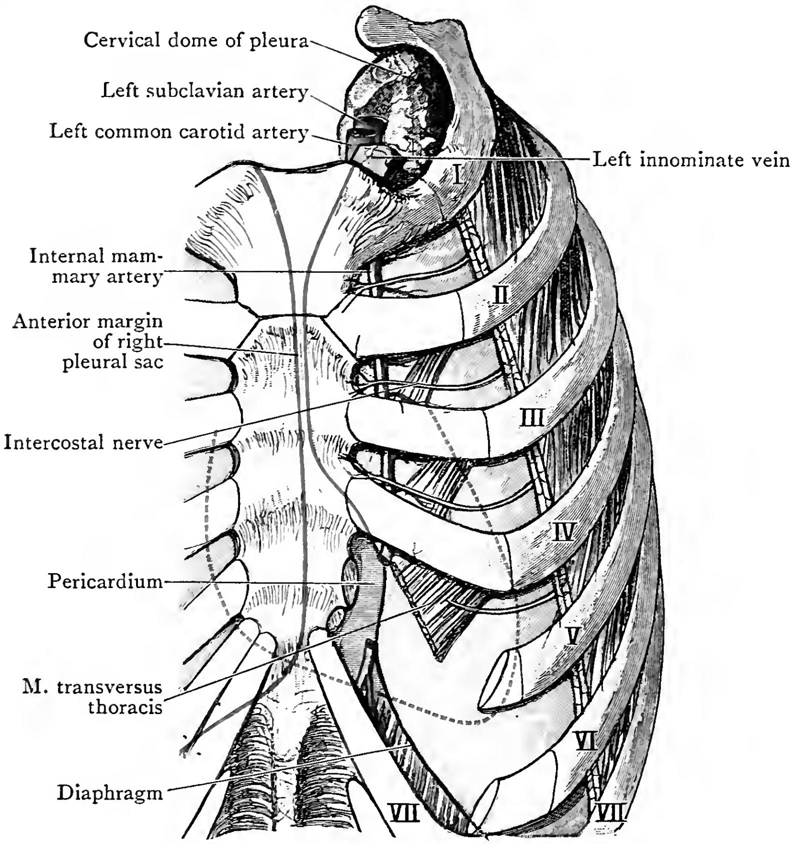

FIG. 8.—Diagram to show the parts which lie anterior to the pericardium and heart. The outline of the heart is indicated in red by a dotted line, and the anterior margins of the pleural sacs are represented by blue lines.

the margin of the sternum, or even 25 mm. (one inch) more laterally; it then descends to the lower border of the sixth cartilage, where it becomes continuous with the lower margin of the pleura, which passes laterally and backwards along the lower border of the sixth cartilage, across the medial end of the sixth space, and across the seventh cartilage to the junction of the cartilage and bone of the eighth rib. The

remainder of its course and the position of its posterior margin are the same as on the right side.

The details given regarding the levels of various parts

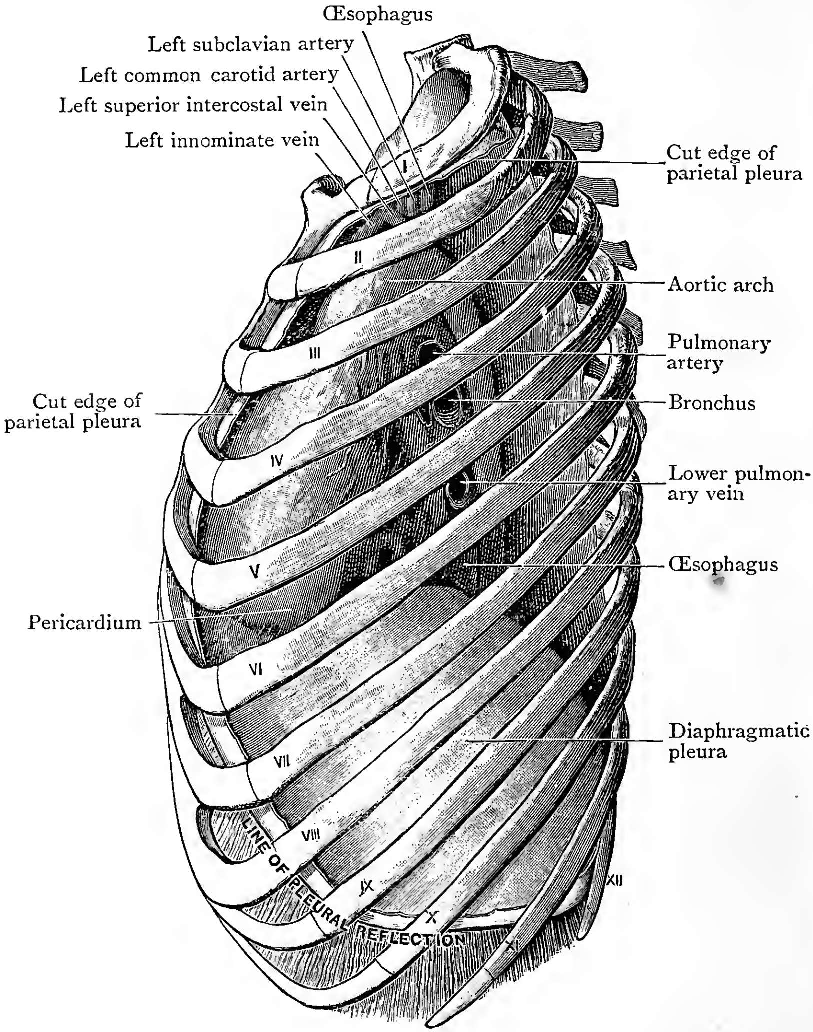

FIG. 9.—Left Pleural Sac, of a subject hardened by formalin injection, opened into by the removal of the costal pleura. The left lung also has been removed so as to display the mediastinal pleura. The line along which the pleura is reflected from the diaphragm on to the thoracic wall is exhibited.

of the inferior borders of the lungs and pleuræ are not easily remembered, and it will be sufficient if the levels on three definite lines are kept in mind. The three

lines are the parasternal, the mid-axillary, and the scapular line.
review

The *parasternal line* is a vertical line, situated midway

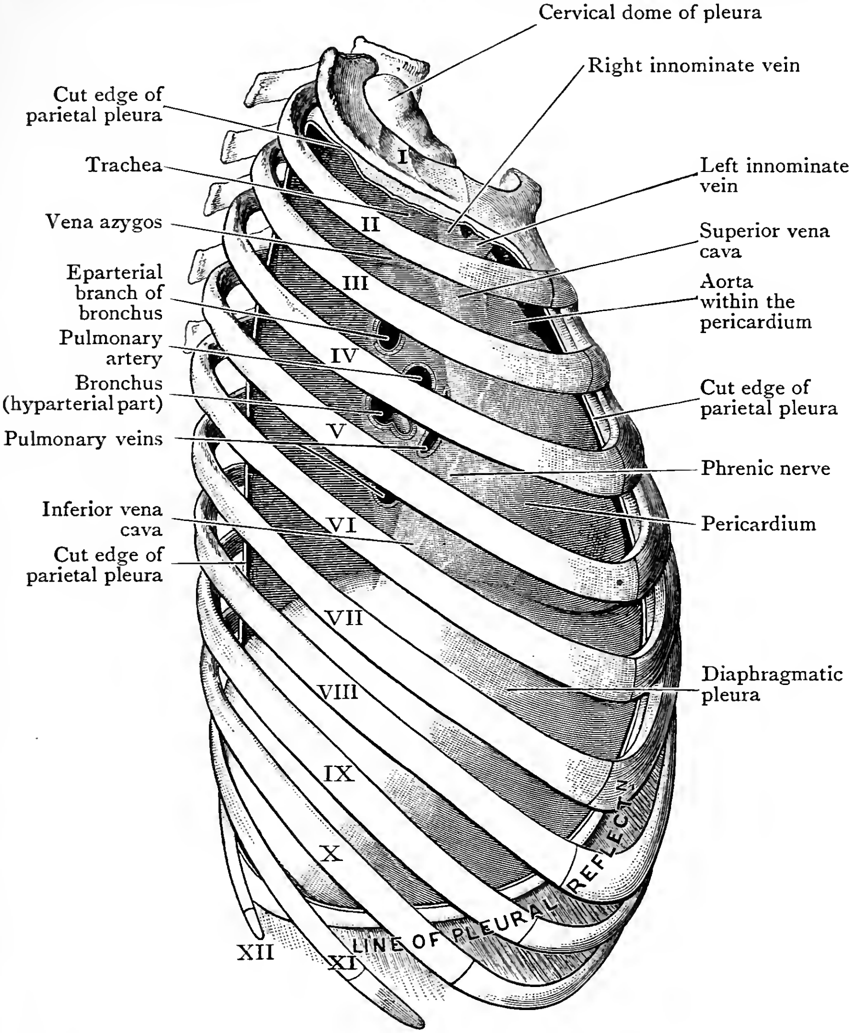

FIG. 10.—The Right Pleural Sac, in a subject hardened by formalin injection, opened into by the removal of the costal part of the parietal pleura. The right lung also has been removed to display the right mediastinal pleura. Note the line of diaphragmatic reflection of the pleura.

between the margin of the sternum and the lateral body line, which is a perpendicular projected vertically upwards, from the mid point between the anterior superior spine of the ilium and the symphysis pubis. The *mid-axillary line* needs

no definition. The *scapular line* is a vertical dropped from

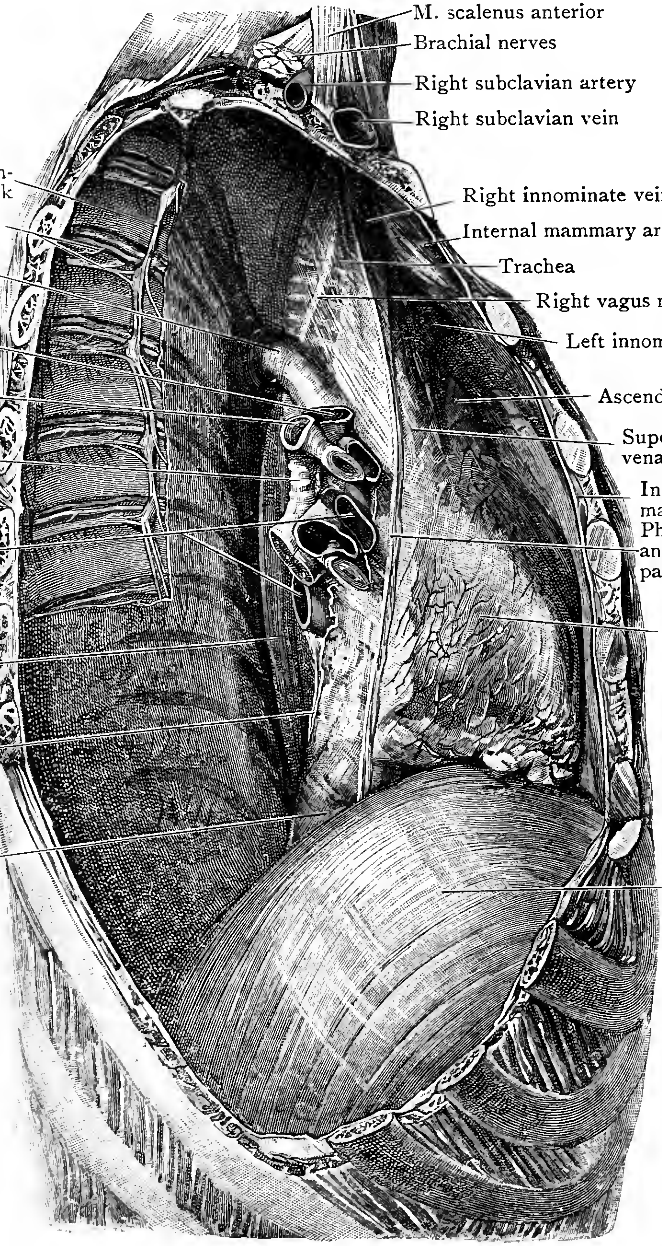

FIG. 11.—The Right Pleural Chamber opened up by the removal of its lateral wall. The lung has been taken away so as to expose the mediastinal wall of the pleural chamber. Several of the structures in the mediastinal septum are seen shining through the mediastinal pleura.

the inferior angle of the scapula when the arm is by the side. The lower margin of the lung lies at the sixth rib in the parasternal line, the eighth rib in the mid-axillary line, and the tenth rib in the scapular line. The lower margin of the pleura is roughly about one rib lower; it lies at the seventh rib in the parasternal line, the ninth rib in the mid-axillary line, and the eleventh rib in the scapular line. The points given are only approximate, but they are sufficient for most practical purposes, and are easily remembered. It should be noted that, on account of the obliquity of the ribs, a horizontal line drawn round the thorax at the level of the point where the parasternal line cuts the sixth rib will cut the eighth rib in the mid-axillary line and the tenth rib in the scapular line; but the inferior margin of the lung is not quite horizontal; on the contrary, it is slightly convex downwards; therefore, when the line indicating its position is drawn the convexity must be allowed for. Further, the student must not forget that the line of the lower margin of the pleura is fixed, but the lower margin of the lung varies in position, being highest at the end of expiration and lowest at the end of inspiration, and the amount of its possible excursion varies in different persons.

Keeping the above-mentioned points in mind, the student should mark out the margins of the pleural sacs on the living body, using himself and his friends for the purpose, until he can indicate them correctly, judging from the contour of the body alone and without feeling for the skeletal points.

After the dissector has made himself thoroughly conversant with the limits of the pleural sacs, he should examine the cut section of the root of the lung, and should endeavour to recognise, through the mediastinal part of the parietal pleura, the positions of the main constituent parts of the mediastinum. As these vary on the opposite sides, each side must be considered separately, and each dissector must make himself well acquainted with the conditions on both sides.

On the right side, in the posterior part of the face of the section of the lung root, at least two parts of the bronchial tube will be seen; an upper, which is the so-called eparterial bronchus, and a lower, the main stem of the right bronchus. Anterior to and between the two bronchi is the pulmonary artery, and more anteriorly, and at a slightly lower level, the upper pulmonary vein. The lower pulmonary vein lies in the lowest

part of the root, below and slightly posterior to the main bronchus. If the specimen is well injected, branches of the right bronchial artery may be distinguished on the posterior faces of the air tubes; and anterior to and between the great blood-vessels, and between them and the bronchi, are a number of bronchial glands, which are easily distinguished by the black pigment deposited within them.

On the left side, in the posterior part of the root of the lung, the dissectors will see the cut section of the left bronchus, and, in many cases, a section of its first ventral branch also. The left pulmonary artery is above the bronchus, and its anterior wall is on a slightly anterior plane. The upper left pulmonary vein is anterior to the bronchus, and the lower left pulmonary vein is below the bronchus. In a well injected specimen the two left bronchial arteries may be seen on the posterior wall of the bronchus, and a number of bronchial glands will be found between and around the large blood-vessels and the bronchus.

Turning next to the mediastinal pleura *on the right side*, the dissectors will note, anterior to and below the root of the lung, a large bulging, due to the heart and pericardium, which lie in the middle mediastinal area. Continuous with the upper and lower ends of the posterior part of this bulging they will see two longitudinal elevations. The upper, from the level of the third costal cartilage to the lower margin of the first rib, is due to the superior vena cava, and above that level, to the right innominate vein. The lower elevation is very short, and is caused by the upper part of the inferior vena cava. A secondary ridge, formed by the phrenic nerve and the accompanying blood-vessels, descends along the elevation caused by the innominate vein and the superior vena cava, crosses anterior to the root of the lung, runs down along the posterior part of the bulging due to the heart, and the anterior border of the inferior caval elevation. Arching over the root of the lung is a curved ridge, due to the upper part of the vena azygos, as it passes forwards to join the superior cava. Above the vena azygos and posterior to the superior cava, the right surface of the trachea, or main air tube, may be seen or felt in the superior mediastinal region, and, descending obliquely across it, from above downwards and backwards, the right vagus nerve can be palpated or seen. Behind to the root of the lung and to the bulging

due to the heart, the œsophagus may be recognised in the posterior mediastinal area, either by touch or sight, or both. Somewhat posterior to the œsophagus the margin of the ascending portion of the vena azygos may be noted, and still further back are the bodies of the vertebræ and the posterior parts of the ribs. Crossing the bodies of the vertebræ horizontally, the right intercostal vessels may be visible or they may be felt, and, descending along the line of the heads of the ribs, the sympathetic trunk and the roots of the greater splanchnic nerve can be recognised by touch, if not by sight.

Examine next the mediastinum and the posterior wall of the thorax on the left side (see Figs. 9, 12, and 14).

By inspection and palpation the positions of the larger and more important structures are easily recognisable. Below and anterior to the root of the lung the mediastinal pleura is bulged much more laterally on the left than on the right side by the heart covered by the pericardium. Arching backwards and to the left, above the root of the lung, in the superior mediastinal area, is the arch of the aorta, and from its posterior end the descending aorta runs downwards, in the posterior mediastinal area, first posterior to the root of the lung, and then posterior to the heart, but separated, in part, from the heart by the œsophagus, which diverges towards the left side in the lower part of the thorax. Above the arch of the aorta the left common carotid and subclavian arteries and the œsophagus can be distinguished, in the above order antero-posteriorly. A long, slender secondary ridge, produced by the left phrenic nerve and the accompanying vessels descends along the line of the common carotid artery, crosses the arch of the aorta, and then continues along the side of the pericardium. Above the aortic arch, and posterior to the ridge caused by the phrenic nerve, the left vagus nerve can be seen or felt, as it runs downwards along the anterior border of the left subclavian artery, and then downwards and backwards across the arch of the aorta, to disappear behind the root of the lung. Posterior to the descending aorta the sympathetic trunk of the left side can be seen or palpated as it descends along the line of the heads of the ribs.

Anterior to the pericardium and the aortic arch and its branches, the mediastinal pleura passes forwards to the back of the sternum, in contact with the pleura of the opposite side.

When the inspection and palpation of the structures

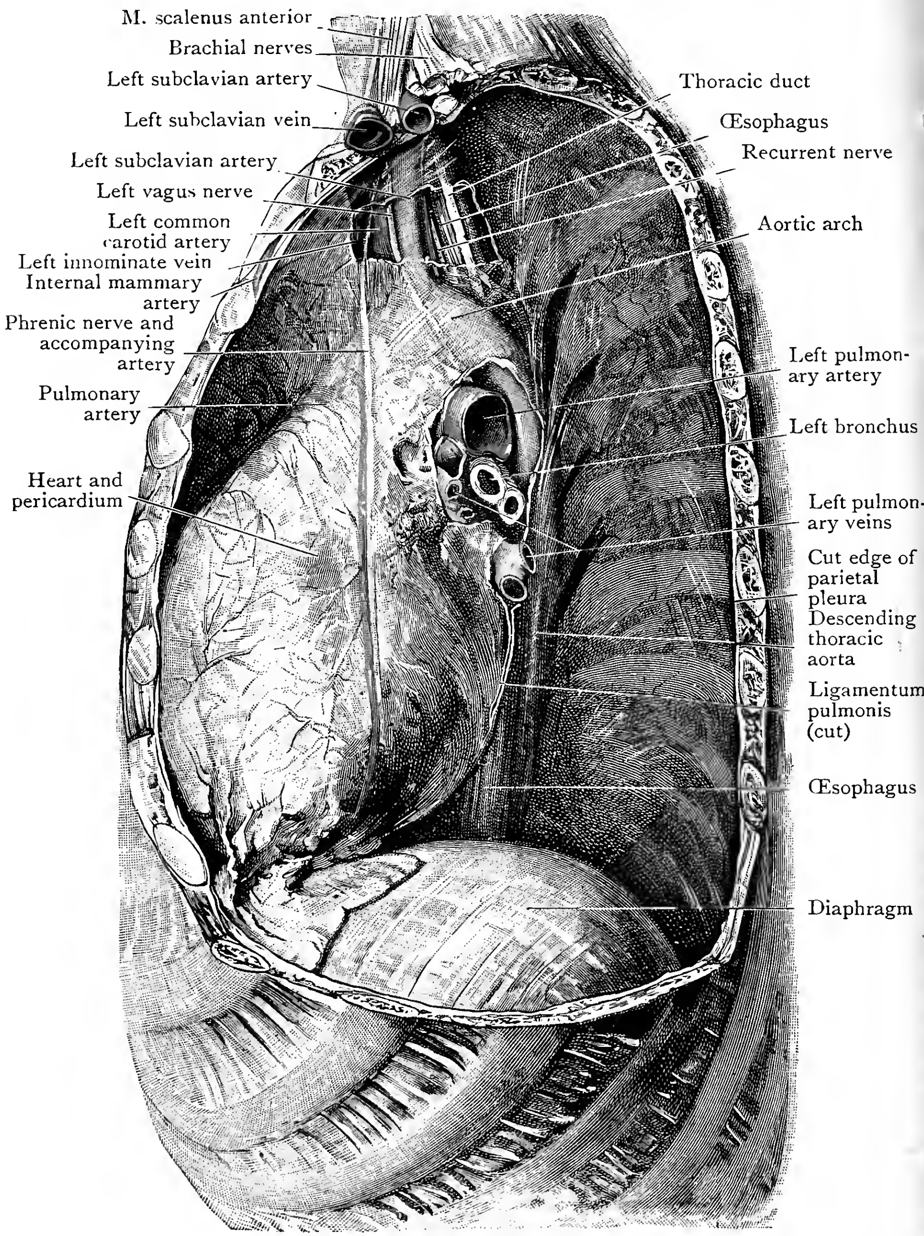

FIG. 12.—The Left Pleural Chamber opened up by the removal of its lateral wall. The lung has been taken away and a "window" has been made into the superior mediastinum by the removal of a portion of the mediastinal pleura. Several of the structures which form the mediastinal partition are seen shining through the mediastinal pleura which is *in situ.*

lying in relation with the mediastinal and posterior parts of the costal pleura are satisfactorily completed, the greater part of the pleura should be removed on both sides.

Dissection.—Make a longitudinal incision through the mediastinal pleura immediately anterior to the phrenic nerve, and a similar incision posterior to the nerve.

From the anterior longitudinal incision an incision should be carried forwards, at the level of the middle of the root of the lung, and from the posterior longitudinal incision another cut should be carried backwards to the front of the root of the lung and then along its anterior surface. Then the root of the lung should be turned forwards and an incision should be made on its posterior surface parallel with that already made on the anterior surface. This incision should be carried backwards from the root of the lung across the posterior part of the wall of the mediastinum, and then laterally, across the posterior wall of the thorax. When the incisions are completed four flaps will be marked out, two anterior and two posterior.

The upper anterior flap on the right side must be turned forwards to the level of the anterior border of the superior vena cava, where it may be cut away, the portion of the pleura extending from the superior vena cava to the sternum being left *in situ*. The upper anterior flap on the left side should be turned forwards to the anterior part of the arch of the aorta and the anterior surface of the upper part of the pericardium, where it should be cut away, the part extending further forwards to the sternum being left in position. The lower anterior flap on each side must also be turned forwards till the anterior part of the pericardium is reached. There it may be cut away, but the portion of pleura extending from the pericardium to the sternum should not be interfered with at present.

The posterior flaps on each side should be completely removed, care being taken to avoid injury to any of the structures which they cover.

After the pleural flaps have been removed the structures which are exposed must be cleaned.

On the right side commence with the vena azygos, as it arches over the root of the lung; follow it backwards and then, as far as possible, downwards, raising the right margin of the œsophagus where it overlaps the vein. Then clean the sympathetic trunk, which lies along the heads of the ribs, secure the two branches which pass backwards from each of its ganglia to the corresponding intercostal nerve and the branches which pass forwards from the lowest five of the eleven ganglia to form the greater and the lesser splanchnic nerves. Trace the splanchnic nerves as far downwards as possible. Attempt to find some of the branches which pass from the upper ganglia of the sympathetic trunk to the pulmonary plexus on the back of the root of the lung. Then clean the right aortic intercostal arteries and the intercostal veins as they cross the bodies of the vertebræ, and in the posterior parts of the intercostal spaces. The medial parts of the arteries cannot be traced at present. Clean also the branches of the superior intercostal artery which pass to the first two intercostal spaces. Note (1) that all the aortic inter-

costal arteries and all the intercostal veins except the first pass behind (external to) the sympathetic trunk (Fig. 13); (2) that the two intercostal branches from the superior intercostal artery do not pass behind the sympathetic trunk (Fig. 6); (3) that the intercostal vein from the first intercostal space passes upward to join the right innominate vein; (4) that the intercostal veins from the second, third, and sometimes that from the fourth also, join together to form a common trunk called the *right superior intercostal vein*, which terminates in the vena azygos; (5) that all the remaining intercostal veins on the right side end directly in the vena azgyos.

Next clean the right vagus. It descends along the right side of the trachea, passes medial to the arch of the vena azygos, and breaks up, on the back of the root of the lung, into the posterior pulmonary plexus. Look for fine branches which pass from its anterior border to the front of the root of the lung, where they join the anterior pulmonary plexus; then clean the posterior pulmonary plexus and trace the continuation of the vagus from it to the wall of the œsophagus, but do not follow it further at present. As the posterior pulmonary plexus is being cleaned look for the branches of the right bronchial artery which ramify on the posterior surfaces of the bronchi. Next clean the right side of the trachea from the vena azgyos to the upper aperture of the thorax and the right margin of the œsophagus, which lies posterior to the trachea. Follow the œsophagus as far as the back of the root of the lung, but do not injure the vena azygos. Finally, clean the pericardium and the superior and inferior venæ cavæ, behind and in front of the strip of pleura left covering the phrenic nerve (Fig. 13).

On the left side, after the pleural flaps have been removed, clean first the *left superior intercostal vein*. It runs from behind forwards, obliquely across the aortic arch, superficial (lateral) to the left vagus nerve. Follow it forwards only as far as the strip of pleura which was left in position covering the phrenic nerve. Then follow it backwards, and note that it is formed by the union of the intercostal veins of the first, second, and third intercostal spaces (Fig. 14), unless, as on the right side, the first intercostal vein passes to the innominate vein. Next clean the left sympathetic trunk. Secure the two branches which pass backwards from each of its ganglia to the corresponding intercostal nerve, and the branches which pass forwards from the lowest five of the eleven ganglia to form the greater and the lesser splanchnic nerves. Follow the splanchnic nerves as far as possible downwards. Attempt to find some of the branches which pass forwards from the upper ganglia to the left posterior pulmonary plexus. Then pull the descending aorta as far forwards as possible, and clean the left aortic intercostal arteries and the accompanying veins and the intercostal branches of the left superior intercostal artery. Note (1) that the upper two intercostal arteries are derived from the superior intercostal artery, and that they do not pass posterior to the sympathetic trunk; (2) that all the other intercostal arteries and veins pass posterior to (external to) the sympathetic trunk, except the left superior intercostal vein which is formed by the union of three or more intercostal veins after they have crossed the sympathetic trunk; (3) that the fourth, fifth, sixth, and seventh, and some-

times the eighth intercostal veins end in a common trunk called the accessory hemiazygos vein, which passes behind the aorta and the œsophagus to join the azygos vein ; (4) that the remaining intercostal veins end in a common trunk called the hemiazygos vein, which also passes behind the aorta and the œsophagus to join the azygos vein.

Next clean the left vagus nerve as it descends along the front of the left subclavian artery and across the arch of the aorta. Attempt to find the small branches which pass from it to the anterior pulmonary plexus on the front of the root of the lung, and springing from its medial side, at the level of the aortic arch, find its recurrent branch, which dips backwards below the arch. Then follow the vagus to the posterior pulmonary plexus on the back of the root of the left lung. Clean the plexus and follow the vagus from it to the œsophagus, but not further at present. Then clean the descending aorta. Now turn to the interval between the left vagus and the strip of pleura covering the left phrenic nerve, and dissecting carefully in the areolar tissue find two small nerves, the superior cervical cardiac branch of the left sympathetic trunk and the inferior cervical cardiac branch of the left vagus. The sympathetic cardiac branch is next the vagus and the vagus cardiac branch next the phrenic nerve. When the two small cardiac nerves have been found do not trace them, at present, below the lower border of the aortic arch, but turn to the left subclavian artery and clean it. Then clean carefully the area behind it and display the left border of the œsophagus, with the left recurrent nerve running along its anterior margin, and the thoracic duct ascending along its posterior margin (Fig. 14, in which the recurrent nerve is seen but is not labelled). Lastly, clean the pericardium in front of and behind the strip of pleura covering the left phrenic nerve.

Contents of the Mediastinum and the Structures of the Posterior Wall of the Thorax seen from the Right Side.—After the pleura has been removed from the right side of the thorax and the extra-pleural tissue has been dissected away, the following structures are exposed. Below and anterior to the root of the lung is the pericardium, covering the right atrium of the heart. Entering the pericardium below and posteriorly is the thoracic part of the inferior vena cava, and entering the upper part is the superior vena cava. The upper end of the superior vena cava is continuous with the right innominate vein, which lies posterior to the sternal end of the first costal cartilage. Arching over the root of the lung, to join the superior vena cava, is the terminal part of the azygos vein. Above the azygos vein and posterior to the superior vena cava are parts of the trachea, the right vagus nerve, and the œsophagus. On the posterior surface of the root of the lung is the posterior pulmonary plexus, formed by

the vagus nerve; and posterior to the lung root is the vena azygos. At a lower level, posterior to the pericardium, the

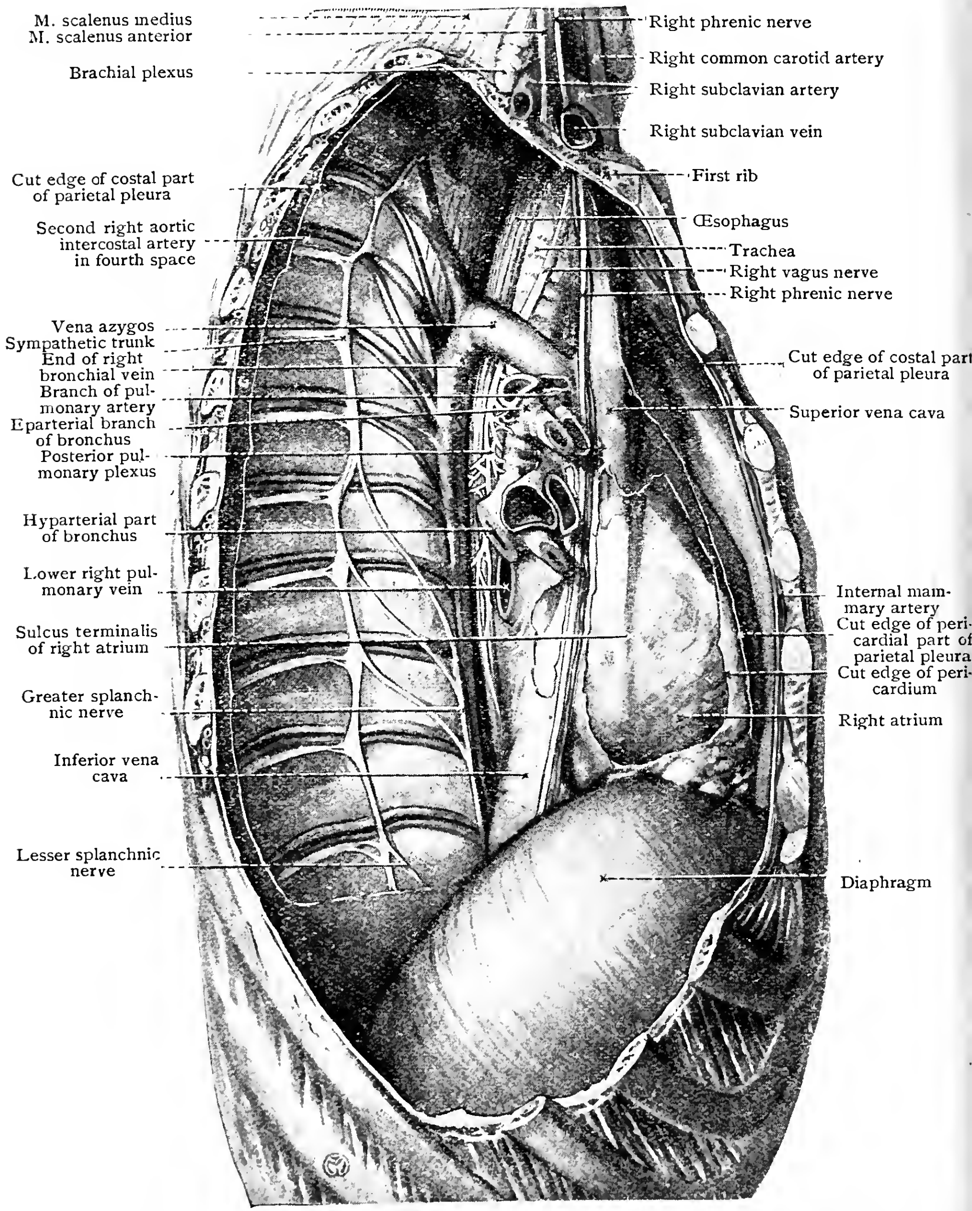

FIG. 13.—Dissection of Thorax from right side showing the constituent parts of the middle, superior and posterior mediastina.

right margin of the œsophagus will be found anterior to the vena azygos. Lateral to the vena azygos, on the sides of the

bodies of the vertebræ, lie the right aortic intercostal arteries, the accompanying veins, and the splanchnic nerves. Still more laterally, on the line of the heads of the ribs, runs the sympathetic trunk, and beyond the sympathetic trunk are the intercostal spaces and their contents (Fig. 13).

The phrenic nerve still covered by the strip of pleura left *in situ* descends along the right innominate vein, the superior vena cava, the pericardium, and the inferior vena cava.

Contents of the Mediastinum and the Structures of the Posterior Wall of the Thorax seen from the Left Side.—After the removal of the four pleural flaps, described on p. 33, and the extra-pleural areolar tissue, the following structures are visible in the thorax on the left side (see Fig. 14). Below and anterior to the root of the lung is the pericardium, covering the left atrium, the left ventricle, the conus arteriosus of the right ventricle and the pulmonary artery. Above the root of the lung is the arch of the aorta. The arch of the aorta terminates posteriorly in the descending aorta, which passes downwards behind the root of the lung and the pericardium, but it is separated from the lower part of the posterior wall of the pericardium by the œsophagus, which, at that level, is inclining towards the left side. On the left and anterior aspect of the aortic arch, from behind forwards, lie the left vagus nerve, the superior cervical cardiac branch of the left sympathetic trunk, the inferior cervical cardiac branch of the left vagus, and the left phrenic nerve, with its accompanying vessels. Crossing the arch obliquely, from behind forwards and upwards, is the left superior intercostal vein, which passes lateral to the vagus and medial to the phrenic nerve. Above the arch of the aorta are the lower parts of the left common carotid and left subclavian arteries, and posterior to the latter lies the œsophagus, with the thoracic duct running along its left border on a posterior plane, and the left recurrent nerve ascending along its anterior margin.

Posterior to the descending aorta are the left aortic intercostal arteries, the accompanying veins, and the splanchnic nerves; and still more posteriorly and laterally lie the sympathetic trunk of the left side and the left intercostal spaces and their contents.

After the relative positions of the structures exposed by the removal of the mediastinal pleura have been examined

on both sides, the dissectors should study the sympathetic trunks and their branches and communications.

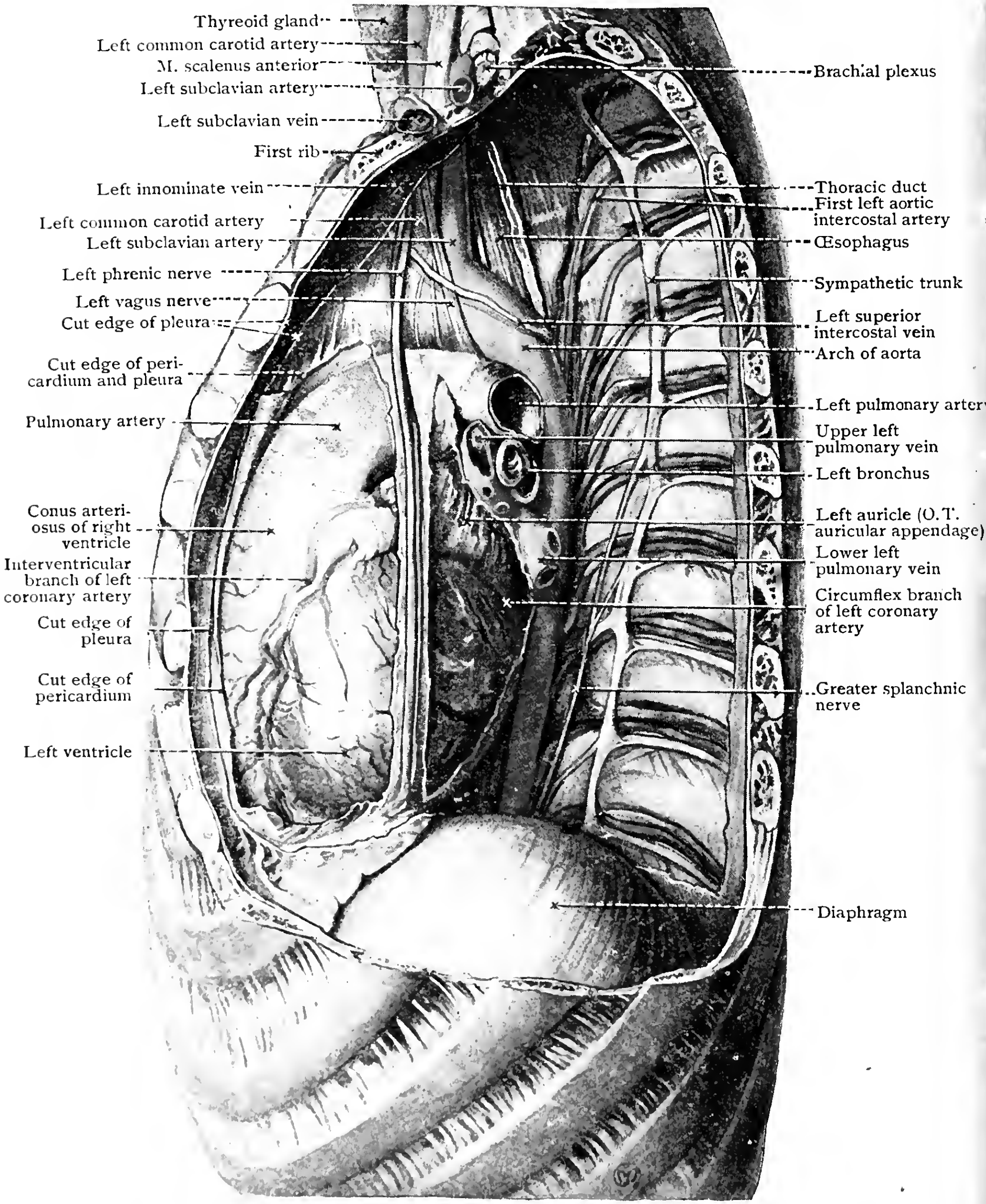

FIG. 14.—Dissection of Thorax from left side showing the constituent parts of the superior, middle and posterior mediastina.

The Truncus Sympathicus.—The thoracic portion of the sympathetic trunk on each side is continuous above with the

cervical portion and below with the abdominal portion. It has the appearance of a knotted cord. The knots are ganglia, which consist of nerve cells and fibres. The intermediate parts of the trunk consist of nerve fibres alone. There are usually eleven ganglia, and, as a rule, each ganglion lies opposite the head of a rib, but the first is opposite the medial end of the first intercostal space, or anterior to the neck of the first rib; and, as the trunk inclines forwards below, one or two of the lower ganglia lie on the bodies of the lower thoracic vertebræ.

Branches.—The branches of each sympathetic trunk may be divided into two groups—(1) *Lateral*; (2) *Medial.*

(1) *Lateral Branches.*—From each ganglion two branches pass laterally into the adjacent intercostal space, where they join the corresponding intercostal nerve. One of the branches, called the white root of the ganglion, contains medullated fibres which are passing from the medulla spinalis (O.T. spinal cord) through the intercostal nerve to the ganglion. The other, the grey root, consists of non-medullated fibres which are passing from the cells of the ganglion to the intercostal nerve. Some of the fibres of the grey root are distributed with the branches of the intercostal nerve, and others run medially, in the intercostal nerve, to the spinal nerve trunk, whence some are distributed by the posterior ramus and others pass more medially to the membranes of the medulla spinalis.

(2) *Medial Branches.* — (*a*) Pulmonary; (*b*) Aortic; (*c*) Splanchnic. (*a*) The pulmonary branches arise from the second, third, and fourth ganglia. They run forwards to the posterior surface of the root of the lung, where they communicate with branches of the vagus, and assist in forming the posterior pulmonary plexus. (*b*) The aortic branches are fine filaments which arise from the upper five ganglia and pass to the coats of the aorta; the dissector will rarely be able to trace them in an ordinary dissection. (*c*) The splanchnic branches arise from the sixth to the last ganglion, and they run together to form three distinct nerves—the greater, the lesser, and the lowest splanchnic nerves, which are all destined for the abdominal viscera.

Nervus Splanchnicus Major.—The greater splanchnic nerve is formed by the union of four or five roots derived from the sixth to the tenth ganglia, or from the portions of the trunk

between the ganglia. It passes downwards, on the bodies of the vertebræ, enters the abdomen by piercing the crus of the diaphragm, and ends in the cœliac ganglion of the same side.

Opposite the last thoracic vertebra there is frequently a small ganglion upon the greater splanchnic nerve, or connected with it; from that ganglion branches are distributed to the aorta, where they communicate with their fellows of the opposite side.

Nervus Splanchnicus Minor.—The lesser splanchnic nerve arises by two roots either from the ninth and tenth, or from the tenth and eleventh ganglia. It also pierces the crus of the diaphragm and ends in the cœliac ganglion.

Nervus Splanchnicus Imus.—The lowest splanchnic nerve is a minute branch which springs from the last thoracic ganglion. It is frequently absent, but when it is present it pierces the crus of the diaphragm and ends in the renal plexus.

Dissection.—When the study of the thoracic portion of the sympathetic trunk and its branches is completed, the posterior parts of the intercostal spaces should be cleaned and examined. The internal intercostal muscles will be seen passing as far medially as the angles of the ribs. In some cases fibres with the same direction as those of the internal intercostal muscles will be found descending from one rib to the second or third below, across the pleural surfaces of the intervening ribs. Such fibres constitute the *subcostal muscles*, which are very variably developed in different subjects. Sometimes they form an almost complete lining for the posterior part of the thoracic wall, and in other cases they are represented by a few scattered fibres, or they are entirely absent.

After the posterior parts of the intercostal spaces have been cleaned, remove, on both sides, the strip of pleura which was left over the phrenic nerve; then clean the nerve and the accompanying vessels, but do not displace the nerve. If the nerve is accidentally displaced fix it back in position by means of a few stitches, attaching the right nerve to the right innominate vein, the superior vena cava, the pericardium, and the inferior vena cava, along which it runs, and the left nerve to the left common carotid artery, the arch of the aorta, and the pericardium.

After the phrenic nerve has been cleaned the dissector on the left side should follow the recurrent branch of the vagus below the arch of the aorta, and at the lower border of the arch, immediately medial and anterior to the recurrent nerve, he should find a fibrous cord, called the *ligamentum arteriosum*, which connects the inferior border of the arch with the commencement of the left pulmonary artery. The ligament must be carefully cleaned and preserved, but the superficial cardiac plexus which lies medial to it must not be interfered with at present. When the dissection outlined above is completed the dissectors should study the vena azygos, the left superior intercostal vein, the phrenic nerves and their accompanying vessels, and the posterior intercostal membranes.

The Vena Azygos.—The azygos vein enters the thorax through the aortic aperture of the diaphragm, to the right of the aorta and thoracic duct, the lower parts of which will be displayed as the vein is cleaned. After entering the thorax

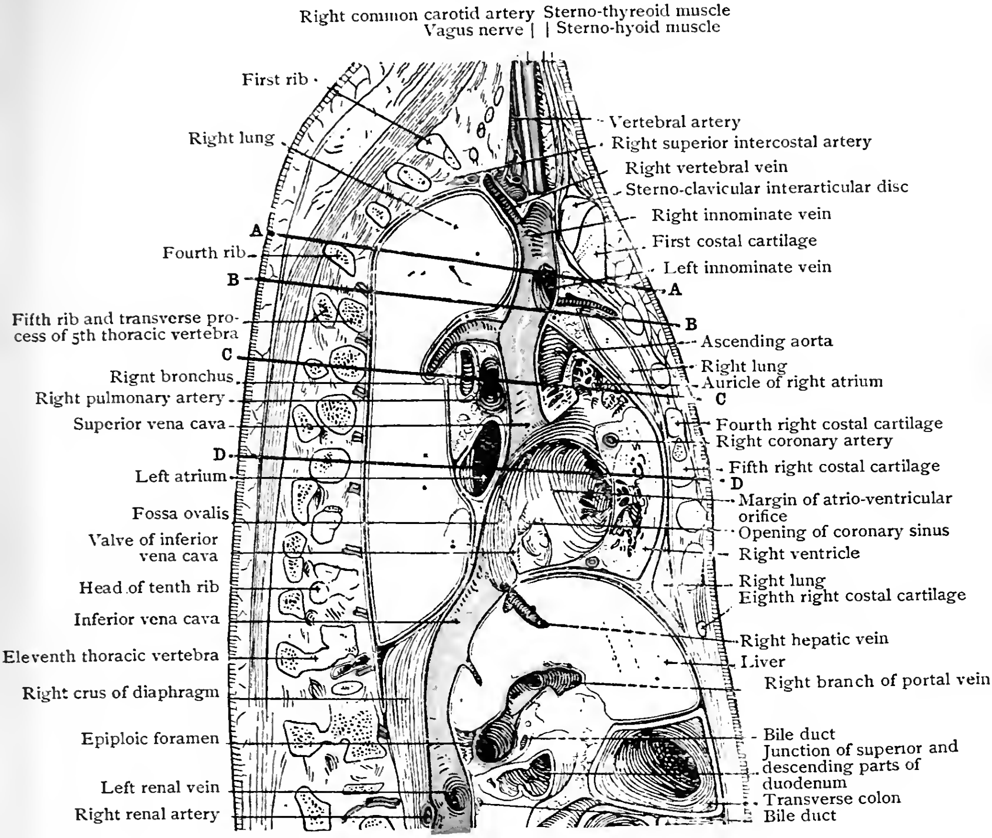

FIG. 15.—Sagittal section and partial dissection of the upper part of the trunk of a young Male Adult. The section is to the right of the median plane along the line of the superior and inferior venæ cavæ and it passes through the right margin of the left atrium of the heart. The atria were partially distended and the ventricles were contracted.

A-A.	Plane of section of	Fig.	22.
B-B.	,,	,,	23.
C-C.	,,	,,	20.
D-D.	,,	,,	21.

the vein ascends along the right side of the aorta, from which it is separated by the thoracic duct. A short distance above the diaphragm it passes more or less completely behind the right border of the œsophagus. At the lower border of the root of the lung it emerges from behind the œsophagus,

passes upwards behind to the root of the lung, turns forwards above its superior border, at the level of the fifth thoracic vertebra, and joins the superior vena cava, on its posterior aspect, immediately above the point where the latter enters the pericardium, at the level of the second costal cartilage (see Figs. 13, 15). As it turns forwards the vein lies immediately to the right side of the œsophagus, trachea and vagus nerve (Figs. 13, 31).

The tributaries of the vena azygos are :—(1) The right superior intercostal vein, which drains blood from the greater part of the second and third intercostal spaces. (2) The lower eight intercostal veins and the subcostal vein of the right side. (3) The vena hemiazygos, and frequently (4) the vena hemiazygos accessoria. Both the latter enter it from the left. In many cases the accessory hemiazygos vein joins the hemiazygos vein. (5) Two or more bronchial veins from the right lung. (6) Some veins from the œsophagus. (7) Some minute pericardial veins.

The vena azygos commences in the abdomen, where it anastomoses either with the ascending lumbar veins (see p. 408) or directly with the inferior vena cava. Thus, it forms a more or less direct anastomosis between the two venæ cavæ.

The intercostal veins and the accompanying arteries and nerves, on both sides, and the hemiazygos and accessory hemiazygos veins will be studied at a later period of the dissection (see p. 140).

The Left Superior Intercostal Vein.—This vein is formed by the intercostal veins from the second and third intercostal spaces of the left side, and it not uncommonly receives communicating veins from the first and fourth spaces. It descends along the medial border of the first left aortic intercostal artery to the posterior end of the aortic arch; there it turns forwards, along the left side of the aortic arch, and, passing at the same time obliquely upwards, it crosses lateral to the left vagus and medial to the left phrenic nerve (Fig. 14). At a later period of the dissection it will be traced to its termination in the left innominate vein.

The Posterior Intercostal Membranes are medial to the internal intercostal muscles and on a more posterior plane. Each is attached, medially, to the anterior costo-transverse ligament, which passes from the neck of the rib below to the

lower border of the transverse process of the vertebra above. Laterally, it is continuous with the fascial layer between the internal and external intercostal muscles, and above and below, it is attached to the adjacent ribs. On the pleural surface of the posterior intercostal membrane, in each space, lie the corresponding intercostal nerve and vessels (see Figs. 13 and 14); they pass laterally, on the internal surface of the membrane, and disappear posterior to the border of the internal intercostal muscle. When the membranes are removed the posterior fibres of the external intercostal muscles will be exposed. They extend, medially, as far as the tubercles of the ribs.

Nervi Phrenici.—Each phrenic nerve arises in the neck from the cervical plexus, receiving fibres from the third, fourth, and fifth cervical nerves. It descends on the scalenus anterior muscle and, on the right side, at the root of the neck, crosses the front of the subclavian artery and runs posterior to the innominate vein; but on the left side, as it leaves the scalenus anterior, it descends parallel with and in front of the subclavian artery and it passes behind the commencement of the innominate vein. As it enters the upper aperture of the thorax it crosses the internal mammary artery, passing from its lateral to its medial side; then it descends along the lateral border of the mediastinum, anterior to the root of the lung, to reach the diaphragm, where it breaks up into branches. The majority of the branches pass between the muscular fibres of the diaphragm and, after communicating with the abdominal sympathetic nerve fibres which form the diaphragmatic plexus, they are distributed to the muscle from its lower surface. The relations of the phrenic nerves in the thorax are different on the two sides.

The *right phrenic nerve* descends along the lateral borders of the right innominate vein and the superior vena cava to the point where the latter enters the pericardium; then along the side of the pericardium, which separates it from the sinus venarum of the right atrium (see Figs. 13, 20, 21, 22, 23).

In the upper part of the thorax the *left phrenic nerve* runs downwards between the left common carotid and the left subclavian arteries and, whilst lying between them, it crosses in front of the left vagus and behind to the left innominate vein. In the lower part of the superior mediastinum it

passes lateral to the arch of the aorta and the left superior intercostal vein; then, descending into the middle mediastinum, it lies at first anterior to the root of the left lung, and afterwards it runs downwards along the side of the pericardium. The pericardium separates it from the auricle of the left atrium and from the left ventricle of the heart.

The left phrenic nerve is longer than its fellow of the right side, partly on account of the lower position of the diaphragm, and partly on account of the greater projection of the heart on the left side.

Branches of the Phrenic Nerves.—The main distribution of the phrenic nerves is to the diaphragm, but some minute sensory twigs are given off by each nerve to the pericardium and to the pleura. The student should note the great importance of the phrenic nerves. They are the nerves of supply to the diaphragm, which is the chief muscle of respiration.

Arteriæ Pericardiacophrenicæ.—The pericardiaco-phrenic artery, one on each side, is given off from the upper part of the internal mammary artery at the root of the neck. Each accompanies the corresponding phrenic nerve, through the superior and middle mediastina, to the diaphragm. It gives branches to the pleura and the pericardium, and it terminates in branches which anastomose, in and on the diaphragm, with the ramifications of the inferior phrenic and musculo-phrenic arteries. Each pericardiaco-phrenic artery is accompanied by venæ comites, which end in the internal mammary vein of the same side.

Dissection.—Before the lungs are examined the pericardium should be opened on each side in order that the dissectors may make themselves familiar with the relations of the heart to the mediastinal pleura, and to the mediastinal surface of the lungs.

Two longitudinal incisions must be made on each side, one anterior and one posterior to the phrenic nerve (see Figs. 13 and 14). On the right side the incisions should commence at the level of the upper pulmonary vein. On the left side the anterior incision should begin at the lower border of the aortic arch, and the posterior at the level of the left pulmonary artery (see Fig. 14). On both sides the longitudinal incisions must descend to the lower border of the pericardium. On both sides incisions should be carried forwards from the upper and lower ends of the anterior longitudinal incision to the line along which the mediastinal pleura was left attached to the anterior surface of the pericardium (see Figs. 13 and 14). From the upper end of the posterior longitudinal incision on the right side a cut should be made downwards and backwards, along the anterior aspect of the root of the lung, to the upper end of the inferior vena cava (see Fig. 13).

From the upper end of the posterior longitudinal incision on the left side an oblique cut must be made downwards and backwards, along the line of the anterior surface of the root of the left lung. When the incisions have been made, the anterior flaps can be turned forwards and the posterior flaps downwards. None of the flaps must be removed, for it will be necessary to replace them in position at a later stage of the dissection.

When the flaps marked out by these incisions are turned aside, the dissectors will find that, on the right side, they have exposed the greater part of the right atrium (see Fig. 13). They should note that the area of the atrium which is exposed is separated into two parts by a vertical sulcus, the *sulcus terminalis*, which runs from the anterior face of the cardiac end of the superior vena cava to the anterior aspect of the terminal part of the inferior vena cava. This sulcus divides the atrium into a posterior part, the *sinus venarum*, and an anterior part, the *atrium proper*. The upper and anterior part of the atrium is prolonged medially to the anterior surface of the heart. On the left side, the greater part of the heart exposed by the reflection of the pericardial flaps is the left ventricle, but in the upper part of the area the auricle (O.T. auricular appendage) of the left atrium is seen. Anterior to it lie the stem of the pulmonary artery and the upper part of the anterior portion of the right ventricle. A line of fat, in which lie the interventricular branch of the left coronary artery and the accompanying vein, indicates the position of the septum between the left and right ventricles (Fig. 14).

After the dissection is completed and the dissectors have carefully noted the relative positions of the various structures which have been exposed, they should proceed to study the lungs.

Pulmones.—The lungs are two comparatively light organs placed one on each side of the mediastinum. They are soft and spongy in texture, and if a small portion is pressed between the fingers and thumb a peculiar sensation called *crepitation* is felt, as the contained air is forced from one part to another. The ground colour of the surface of the adult lung of town-dwellers is slate-blue, but it is mottled with patches and fine lines of black, caused by deposited carbon particles. The lungs of children are of a yellowish-pink colour, similar to the colour of the lungs of healthy sheep.

The elasticity of the healthy lung substance is remarkable, but the student will not be able to demonstrate it in a lung hardened by formalin or injured by disease. He can, however, obtain from a butcher the fresh lungs of a sheep, and then, by inflating them through the trachea with the aid of a bellows, he will have no difficulty in satisfying himself of their elasticity. If, in the thorax under dissection, the lungs

are healthy and not hardened, the dissectors found when they opened the pleuræ that the lungs shrank to about one-third of their original bulk (see p. 19). In such cases, with the consent of the dissectors of the head and neck, the dissectors have already distended the lungs and examined their elasticity (see p. 23).

The weight of an adult healthy right lung, containing an average amount of blood, is about 620 grm. (22 oz.), and

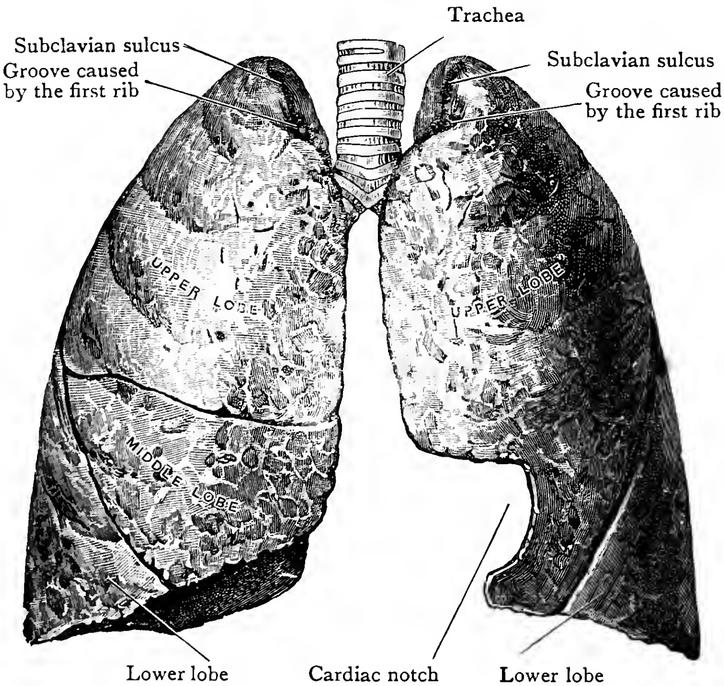

FIG. 16.—The Trachea, Bronchi, and Lungs of a Child, hardened by formalin injection.

that of the left is 570 grm. (20 oz.). The whole lung, or any healthy portion of it, will float in water.

A lung which will not float in water is either diseased or it has been taken from the body of an infant which has not breathed. Before the first respiration, which takes place after birth, the lungs are solid organs, and their bulk is small in proportion to their weight; therefore, when they are removed from the body and placed in water they sink.

The lungs, when healthy and sound, lie free within the cavity of the chest, and are attached only by their roots and by their pulmonary ligaments. It is rare, however, that a

healthy lung is seen in the dissecting-room, for adhesions between the visceral and parietal portions of the pleura, due to pleurisy, are generally present. Each lung is accurately adapted to the space in which it lies, and, when hardened *in situ*, it bears, on its surface, impressions and elevations which are an exact counterpart of the inequalities of the structures with which its surfaces are in contact at the moment of fixation.

Each lung, in the natural condition, resembles half a cone; and it presents for examination an *apex*, a *base*, a *costal surface*, and a *medial surface*. An *anterior* and a *posterior border* separate the medial from the costal surface; and an *inferior*

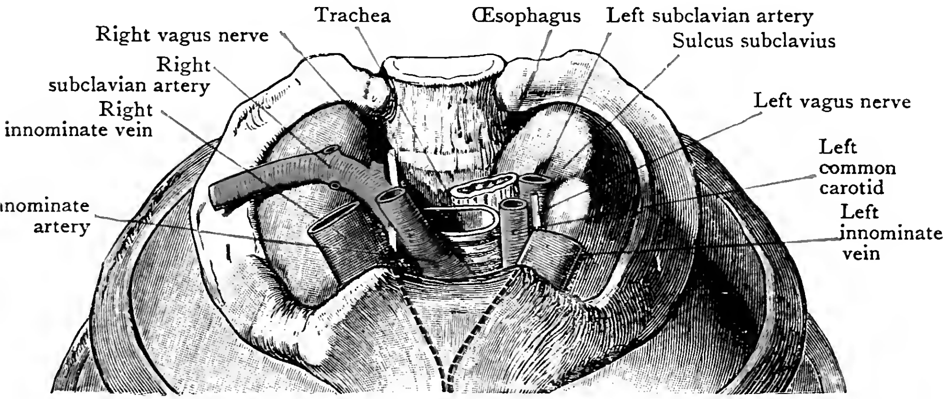

FIG. 17.—Cervical Domes of the Pleural Sacs, and parts in relation to them.

or *basal border* separates the base from the medial and costal surfaces. The apex rises into the root of the neck for one and a half inches above the level of the anterior part of the first rib, and it is crossed by the subclavian artery, which makes a groove upon the anterior border, a short distance below the summit, although the artery is separated from the lung by the membranous cervical diaphragm (Sibson's fascia), and by the pleura.

The base of each lung has a semilunar outline and is adapted to the upper surface of the diaphragm. Consequently it is deeply hollowed out, and, as the right cupola of the diaphragm ascends higher than the left, the basal concavity of the right lung is deeper than that of the left lung. The anterior, lateral, and posterior parts of the inferior margin of the lung are thin and sharp and extend downwards into the

phrenico-costal sinus of the pleura, which intervenes between the diaphragm and the wall of the thorax. The lateral and posterior parts attain a somewhat lower position than the anterior part, but in all parts fall considerably short of the bottom of the sinus. The mediastinal part of the inferior margin, which lies along the lower border of the pericardium, is more rounded.

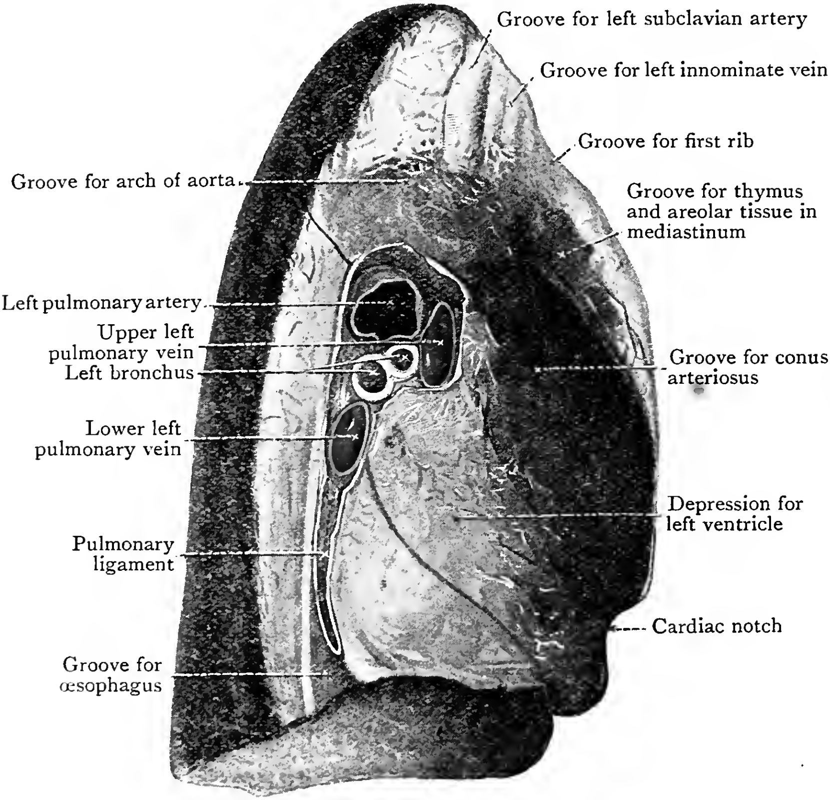

FIG. 18.—The Medial Surface of a Left Lung hardened *in situ*.

The diaphragm separates the base of the right lung from the upper surface of the right lobe of the liver, and the base of the left lung from the left lobe of the liver, the stomach, the spleen, and, in some cases, from the left extremity of the transverse colon.

The *costal surface* of the lung is very extensive and convex. It lies in relation with the costal pleura, which separates it from the ribs and intercostal muscles, the transversus thoracis

and the sternum, and it bears the impressions of the costal arches.

The medial surface is separable into an anterior or *mediastinal portion* and a posterior or *vertebral portion.* The vertebral portion lies against the sides of the bodies of the vertebræ (Figs. 5, 20, 21, 22). The mediastinal part is

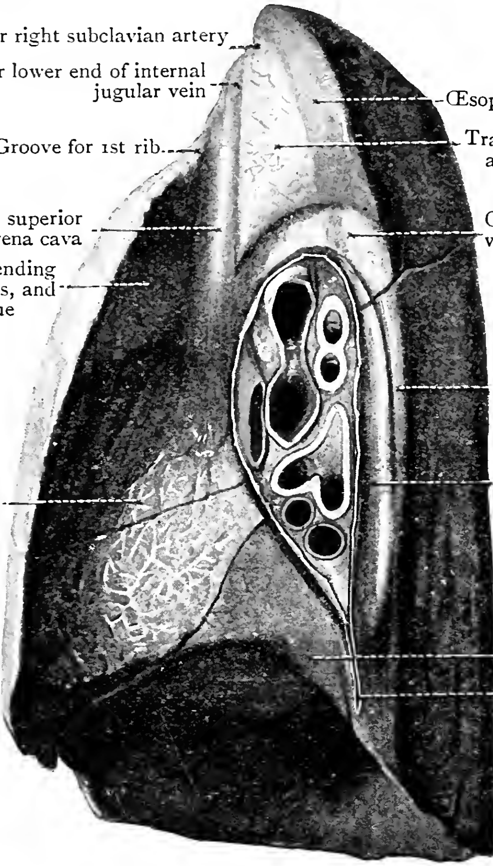

FIG. 19.—The Medial Surface of a Right Lung hardened *in situ.*

applied against the mediastinal partition and presents markings which are the exact counterparts of the inequalities of the corresponding surface of the mediastinum. Thus, it is deeply hollowed out in adaptation to the pericardium, upon which it fits (Figs. 5, 21). The pericardial concavity occupies the greater part of the mediastinal surface, and, owing to the greater projection of the heart to the left side, it is much more extensive in the left lung than in the right lung.

At the upper and posterior part of the pericardial area is the hilum of the lung. This is a wedge-shaped, depressed area through which the bronchus and the pulmonary artery, nerves, veins, and lymph vessels enter or leave the lung. It is surrounded by the pleura which is reflected from its margin on to the root of the lung, and the layer of reflected pleura round

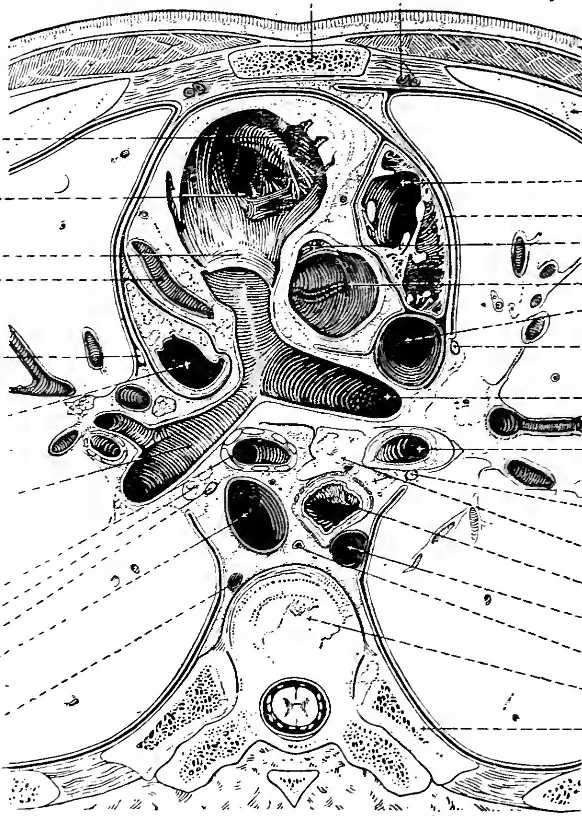

FIG. 20.—Transverse section through the Thorax of a young Male Adult along the plane **C-C**, Fig. 15.

the hilum is continuous, below, with the pulmonary ligament (Figs. 18, 19).

The portion of the pericardial area anterior to the upper part of the hilum of the left lung corresponds with the position of the conus arteriosus and the stem of the pulmonary artery (Fig. 18); and the same portion of the pericardial area on the right side corresponds with the position of the lower part of the superior vena cava posteriorly, and with

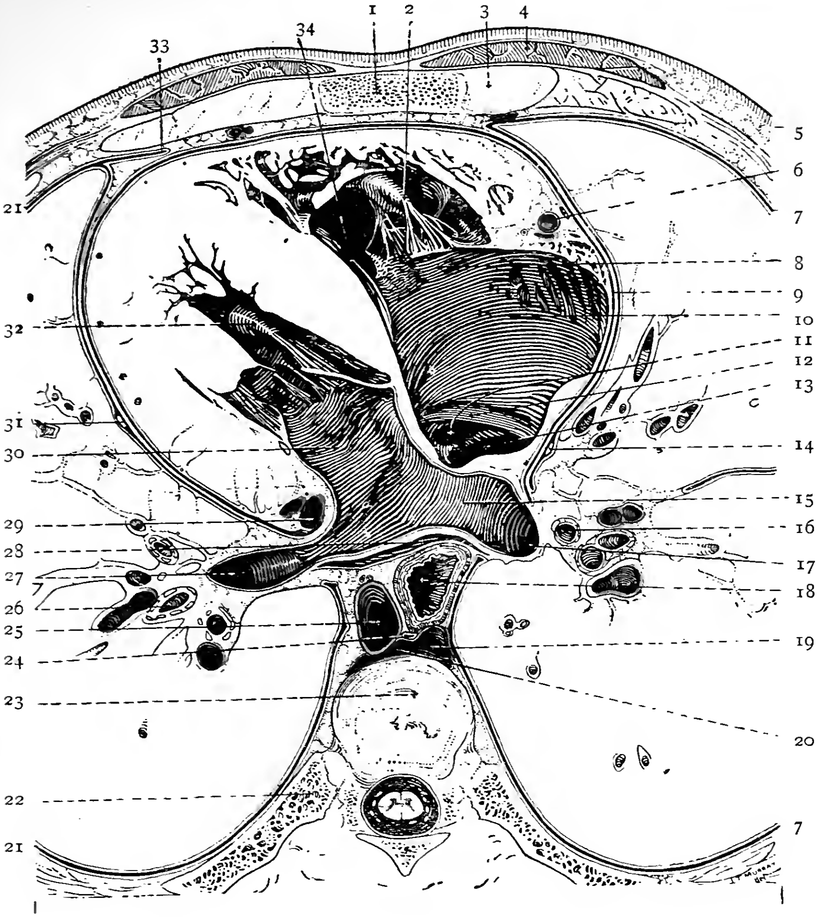

FIG. 21.—Transverse section through the Thorax of a young Male Adult along the plane **D-D**, Fig. 15.

1. Sternum.
2. Papillary muscle of right ventricle.
3. Fifth costal cartilage.
4. Pectoralis major.
5. Skin.
6. Right coronary artery.
7. Cavity of right pleura.
8. Musculi pectinati.
9. Pericardium.
10. Cavity of right atrium.
11. Opening of hepatic vein.
12. Valve of inferior vena cava.
13. Inferior vena cava.
14. Right phrenic nerve.
15. Left atrium.
16. Right bronchus.
17. Lower right pulmonary vein.
18. Œsophagus.
19. Vena azygos.
20. Accessory hemiazygos vein.
21. Cavity of left pleura.
22. Eighth rib.
23. Intervertebral cartilage between seventh and eighth thoracic vertebræ.
24. Thoracic duct.
25. Descending aorta.
26. Left bronchus.
27. Lower left pulmonary vein.
28. Oblique sinus of pericardium.
29. Coronary sinus.
30. Left atrio-ventricular orifice.
31. Left phrenic nerve.
32. Inferior papillary muscle of left ventricle.
33. Anterior margin of left pleura.
34. Septal cusp of tricuspid valve.

the ascending aorta anteriorly (Figs. 19, 20, 56). Below

and behind the lower and posterior part of the pericardial area on the right lung is a secondary depression due to the upper part of the inferior vena cava. Posterior to the pericardial area and the hilum there is a narrow strip of the

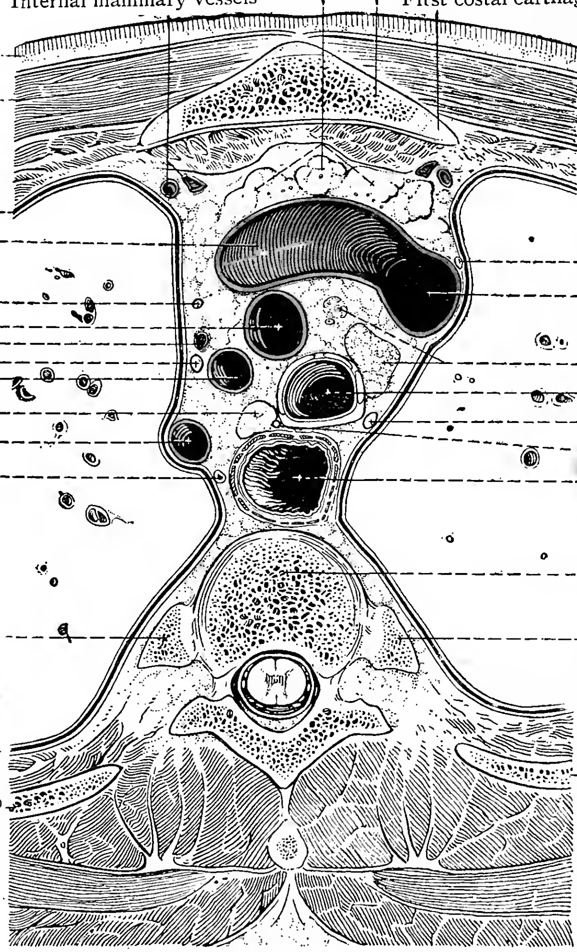

FIG. 22.—Transverse section of the Thorax of a young Male Adult along the plane **A-A**, Fig. 15.
The œsophagus was distended but empty.

mediastinal surface of the lung which is in relation with the lateral wall of the posterior mediastinum. On the right lung this portion of the surface presents a longitudinal depression which corresponds with the right border of the œsophagus, and more posteriorly, at the upper part, there

may be a groove caused by the vena azygos (Fig. 18). The left lung, in the corresponding situation, is marked by a deep longitudinal groove which is produced by the contact of the lung with the descending thoracic aorta; and, close to the base, a small triangular area, anterior to the aortic groove, lies in relation with the left border of the lowest part of the thoracic portion of the œsophagus (Fig. 19).

The portion of the mediastinal surface which lies above the hilum and pericardial hollow is applied to the lateral aspect of the superior mediastinum and the markings upon it are different on the two sides. On the left side, a broad deep groove, caused by the aortic arch, curves over the hilum and becomes continuous posteriorly with the aortic groove on the posterior mediastinal area (Figs. 18, 20, 21). From this arched groove a sharply cut sulcus, caused by the left subclavian artery, ascends on the medial side of the apex (Figs. 18, 22), and, turning laterally above, it crosses the anterior border of the apex a short distance below the summit. Immediately anterior to the subclavian sulcus the medial surface of the apex is occasionally marked by a shallow sulcus caused by the left innominate vein, and more inferiorly its anterior margin is depressed by the first rib. That portion of the surface which lies posterior to the subclavian sulcus is separated by areolar tissue from the œsophagus and thoracic duct.

On the right lung also a curved sulcus arches over the hilum. It is caused by the vena azygos, as it passes forwards to join the superior vena cava. The groove for the vena azygos is much narrower than the sulcus on the left lung due to the aortic arch. From the anterior end of the sulcus for the azygos vein a broad shallow sulcus passes upwards to the lower and anterior part of the apex; it is produced by the superior vena cava and the right innominate vein (Figs. 19, 20, 22), and in some cases it is prolonged to the upper part of the apex by a slight longitudinal depression due to the pressure of the internal jugular vein. Arching laterally, across the upper part of the anterior aspect of the apex, there is a shallow groove produced by the right subclavian artery. Posterior to the sulcus for the innominate vein, the medial surface of the apex lies in relation with the right side of the trachea and the vagus, and still further posteriorly it is either in relation with the right border of the

superior mediastinal part of the œsophagus, or it is separated from it by a quantity of areolar tissue (Figs. 20, 22, 23).

The anterior and posterior borders of the lung are in marked contrast with each other. The anterior is comparatively short and thin, and it extends medially into the costo-

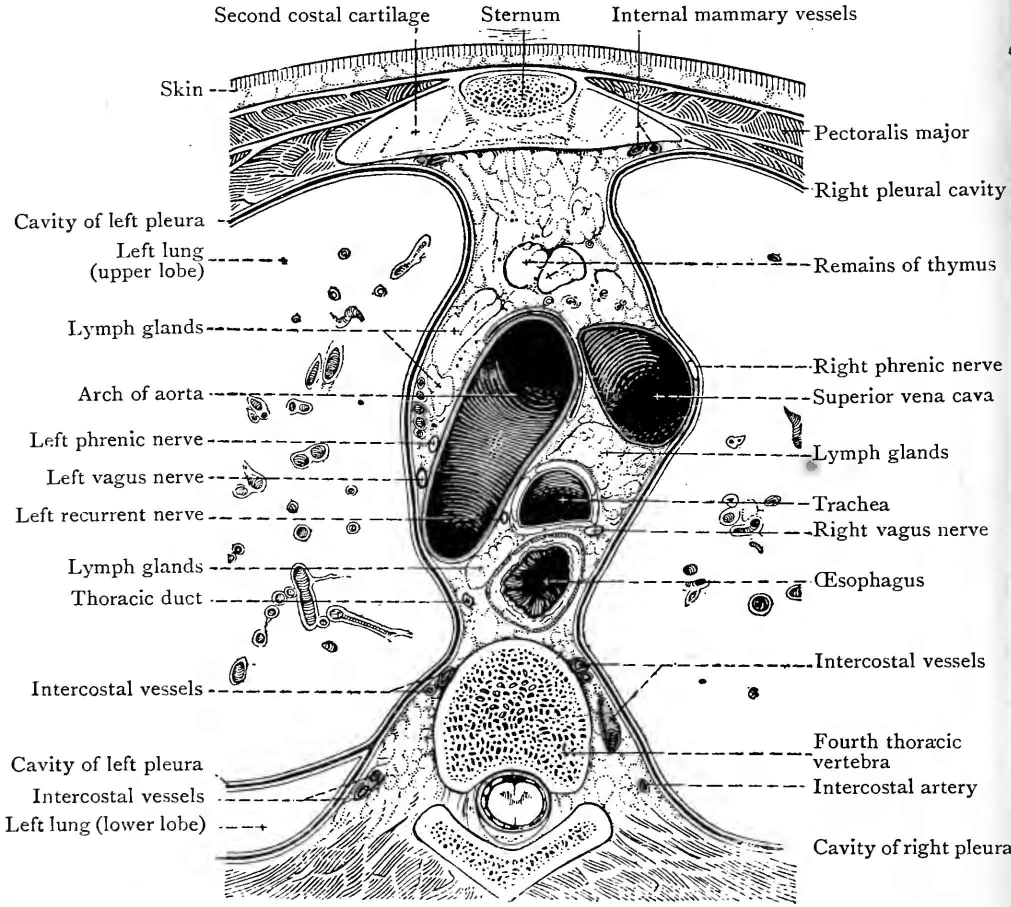

FIG. 23.—Transverse section of the Thorax of a Male Adult along the plane **B-B**, Fig. 15.

mediastinal sinus of the pleura, which lies posterior to the sternum and the costal cartilages. It commences at the apex, curves downwards, forwards and medially, posterior to the sterno-clavicular articulation, to the lower border of the manubrium sterni, and then it descends to the base. Immediately below the highest point of the apex it is grooved

by the subclavian artery on each side, and on the left side it presents a *cardiac notch* at the level of the fifth costal cartilage. The posterior border is rounded and indistinct. It descends from the apex to the base, along the line of the articulations of the heads of the ribs with the bodies of the vertebræ, and it is considerably longer and thicker than the anterior border.

Lobes of the Lungs.—The *left lung* is divided into two lobes by a long, deep *oblique fissure* which penetrates its substance to within a short distance of the hilum. The oblique fissure begins above at the posterior border, about 62 mm. (two and a half inches) below the apex, at the level of the vertebral end of the fourth rib, which corresponds with the medial end of the spine of the scapula and the spine of the third thoracic vertebra. It is continued on the lateral surface, in a somewhat spiral direction, downwards and forwards till it cuts the inferior margin opposite the lateral part of the sixth costal cartilage. The *upper lobe* of the lung lies above and anterior to the oblique fissure. It is conical in form, with an oblique base. The apex and the whole of the anterior border belong to it. The *lower lobe*, somewhat quadrangular, is more bulky than the upper, and lies below and posterior to the fissure; it comprises the entire base and the greater part of the thick posterior border.

In the *right lung* there are two fissures subdividing it into three lobes. The *oblique fissure* is very similar in its position and relations to the fissure in the left lung, but it is more vertical in direction. It separates the lower lobe from the upper and middle lobes. The second cleft, the *horizontal fissure*, begins at the anterior border of the lung at the level of the fourth costal cartilage and extends horizontally till it joins the oblique fissure. The middle lobe, thus cut off, is wedge-shaped in outline. It lies between the oblique and horizontal fissures.

Differences between the two Lungs.—The dissectors should particularly note the following differences between the two lungs:—(1) The right lung is slightly larger than the left, in the proportion of 11 to 10. (2) The right lung is shorter and wider than the left lung. This difference is due to the great bulk of the right lobe of the liver, which elevates the right cupola of the diaphragm to a higher level than the left cupola, and also to the heart and pericardium, which project more to the left than to the right, and thus diminish

the width of the left lung. (3) The anterior sharp margin of the right lung is more or less straight; the corresponding margin of the left lung presents, in its lower part, a marked angular deficiency (*incisura cardiaca*) for the reception of the heart and the pericardium. (4) The right lung is subdivided into three lobes, and the left lung into two.

Dissection.—The cardiac branches of the vagus and the sympathetic trunk which lie on the left surface of the arch of the aorta have already been found (p. 35). Trace them now, from the arch downwards into its concavity, to the right of the ligamentum arteriosum, where they terminate in the superficial cardiac plexus. Clean the superficial cardiac plexus, as far as possible, and trace twigs from it (1) upwards and backwards below the arch of the aorta towards the deep cardiac plexus, (2) downwards to the pulmonary artery and the heart, (3) laterally to the anterior pulmonary plexus of the left side.

The vagi nerves and branches from the thoracic sympathetic ganglia have already been followed to the posterior pulmonary plexuses on each side (p. 33). Now follow some of the branches of the plexus to the walls of the bronchus. Trace towards the œsoph agus other branches which connect the posterior pulmonary plexuses of opposite sides together. They pass both in front of and behind the œsophagus, and are of relatively large size.

When the posterior pulmonary plexuses and their connections have been examined, complete the cleaning of the bronchial arteries which run along the posterior faces of the bronchial tubes; then proceed to a detailed study of the roots of the lungs, using for the purpose the portions of the roots which are still attached to the mediastinum.

Radix Pulmonis.—The root of each lung is formed by a number of structures which enter or leave the lung at the hilum on its mediastinal surface. The main structures are: (1) the bronchial tube, through which air passes to and from the lung; (2) a pulmonary artery which carries venous or de-oxygenated blood from the right side of the heart to the lung to be oxygenated; (3) two pulmonary veins, upper and lower, which convey oxygenated blood from the lungs to the left side of the heart; (4) lymph vessels and lymph glands through which lymph passes on its way from the lung towards the right lymph duct on the right side and the thoracic duct on the left side; (5) one bronchial artery on the right side, and two on the left side, which carry oxygenated blood from the aorta to the walls of the bronchial tubes; (6) the anterior and posterior pulmonary plexuses of nerves and their branches.

The structures which compose the root of the lung are enclosed in a layer of visceral pleura, which has been

removed, and are also bound together by areolar tissue, which is often dense and fibrous in the adult, especially around the lymph glands.

The bronchus is always easily identified by the firm elastic plates of cartilage which help to form its walls, as well as by its posterior position. The pulmonary artery can be distinguished, not only by its intermediate position between the bronchus and the veins, but also, as contrasted with the veins, by the greater relative thickness of its walls. The lymph glands are easily recognisable in the adult by

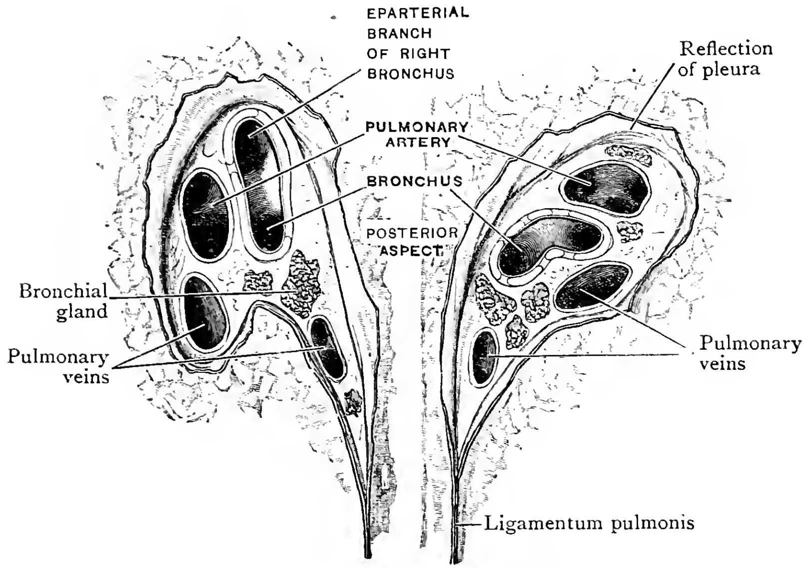

FIG. 24.—The two Pulmonary Roots transversely divided close to the hilum of each lung.

their black or greyish black colour, but in the young child they are yellowish pink in colour and are not so obvious. The bronchial arteries lie on the posterior faces of the bronchi, if they are not well injected they are difficult to trace, and the veins which accompany them are still more difficult to secure.

In both sides one bronchus and one pulmonary artery enter the root of the lung, and two pulmonary veins leave it. As the bronchus and artery enter the root the artery passes in front of the bronchus, and after they enter the hilum of the lung the artery descends behind the bronchus on its lateral side. The pulmonary veins lie at a lower level than

the bronchus and artery, and the upper pulmonary vein is placed in a more anterior plane than either the artery or the bronchus. Before the right bronchus enters the hilum of the lung it gives off a large branch, called the *eparterial branch* because it arises above the level at which the pulmonary artery crosses the front of the main bronchus. There is no corresponding branch from the left bronchus. On both sides the branches given off below the point where the pulmonary artery crosses the main stem bronchus are called *hyparterial branches.* It necessarily follows from what has already been stated that in sections made through the root of the lung, at right angles to its long axis, the relative positions of the structures will vary slightly according to whether the section is nearer to or farther from the median plane; but in all such sections the upper pulmonary vein will lie in an anterior plane, the pulmonary artery in an intermediate plane, and the bronchus in a posterior plane. If the section is made close to the hilum of the lung, the relationship from before backwards, *on both sides,* is upper pulmonary vein, pulmonary artery, stem bronchus. The relationship from above downwards, *on the right side,* is eparterial bronchus, pulmonary artery, stem bronchus, pulmonary vein; and, *on the left side,* pulmonary artery, stem bronchus, pulmonary vein; the difference being due to the eparterial branch from the stem bronchus which is present only on the right side.

The Relations of the Roots of the Lungs.—Anterior to the root of each lung are the phrenic nerve, with its accompanying vessels, and the anterior pulmonary plexus; behind it, the posterior pulmonary plexus; and below it, the ligamentum pulmonis. In addition, in front of the root of the right lung is the superior vena cava; and above and behind it, the vena azygos; whilst above the root of the left lung is the aortic arch, and behind it, the descending aorta (Figs. 18 and 19).

It will be obvious to the dissector who has followed the preceding descriptions that parts of the main stems of the bronchi, the pulmonary arteries, and the pulmonary veins lie medial to the lungs and outside of their substance. They are the *extra-pulmonary parts.* They are only partially displayed at present, and the study of their special relations must be deferred until a later period (see p. 126). The portions of the bronchi and the pulmonary blood vessels

which lie in the substance of the lungs are the intra-pulmonary parts, and an attempt should now be made to display their main relations.

Dissection.—Place the lung with its mediastinal surface uppermost; then follow the pulmonary veins into its substance. They lie in front of the main parts of the bronchi. *On the right side* commence with the upper pulmonary vein. At the hilum it will be found to receive two tributaries, one emerging from the upper lobe, and accompanying the eparterial bronchus, and the other issuing from the middle lobe, accompanying what will afterwards be found to be the first ventral hyparterial branch of the bronchus. It also receives a tributary from the medial part of the lower lobe. As the vein and its tributaries are cleaned, clean also the anterior aspects of the bronchi. Next, follow the inferior pulmonary vein; it accompanies the stem bronchus, below the level of its first ventral hyparterial branch, and it receives tributaries which correspond to all the hyparterial branches of the bronchus, except the first ventral branch and a small branch called the *first ventral accessory bronchus* which is given off from the front of the stem bronchus immediately below the first ventral hyparterial branch. After the veins have been cleaned follow the eparterial bronchus for a short distance into the substance of the upper lobe and note that it is the only bronchus distributed to that lobe. Next clean the hyparterial bronchus and attempt to display its two main sets of branches, *ventral* and *dorsal.* They will be recognised in the adult by their black or greyish-black colour. As the bronchi are being cleaned small pulmonary lymph glands will be met with in the angles between their branches. The ventral branches spring from the lateral border of the stem bronchus and run towards the anterior margin of the lung. The first ventral branch is the only branch distributed to the middle lobe (Fig. 25). The remaining three or four ventral branches and all the dorsal branches pass to the lower lobe.

The dorsal branches arise from the back of the hyparterial part of the stem bronchus and pass towards the thick posterior border of the lung. Clean them from their medial sides. Note that the ventral and dorsal branches arise alternately—first a ventral, then a dorsal. As the dissection proceeds the dissector will find some small hyparterial branches which lie intermediate between the ventral and dorsal branches; they are called *accessory bronchi.* Only one of the group of accessory bronchi is of special interest. It springs from the front of the stem bronchus immediately below the first ventral branch; it is, therefore, the second branch from the hyparterial part of the stem bronchus, and is the first ventral accessory bronchus (Fig. 25). It is of special interest because it is distributed to a portion of lung substance which occasionally becomes a separate lobe called *the infracardiac lobe,* the right lung then possessing four lobes. The artery which accompanies the first ventral accessory bronchus is frequently a branch of the artery to the middle lobe, and the vein terminates in the vein from the middle lobe.

After the bronchi have been cleaned follow the intra-pulmonary part of the pulmonary artery, as it descends along the

postero-lateral aspect of the stem bronchus, between the ventral and dorsal hyparterial branches, and note that its branches correspond with the branches of the bronchus and run chiefly along their posterior aspects.

On the left side follow, first, the upper pulmonary vein, and note that its tributaries are derived only from the upper lobe of the left lung. Then follow the lower vein, which receives blood from the lower lobe. After the veins are displayed clean the hyparterial part of the stem bronchus and its ventral and dorsal branches, cleaning the dorsal branches from their medial sides. Note that the first ventral branch is relatively very large and that it is distributed entirely to the upper lobe, whilst all the other branches, ventral and dorsal, are distributed to the lower lobe. Finally, follow the pulmonary artery along the postero-lateral face of the stem bronchus, and note that it gives off branches which correspond, in number and position, with the branches of the bronchus and that they run along the posterior aspects of the bronchi which they accompany (Fig. 25).

Bronchi.—There are two primary bronchi, one for each lung. They spring from the termination of the trachea and each passes downwards and laterally to the hilum of the lung to which it belongs; then, having entered the lung through the hilum, it descends, in the substance of the lung, to the base. The dissector who has followed the preceding instructions will have noted that as the main bronchial stem traverses the lung substance it lies nearer the medial than the lateral surface of the lung and nearer the posterior than the anterior border. And he should also have noted that the apex of the lung is supplied by branches which ascend to it, whilst the other parts are supplied by branches of the bronchus which run mainly forwards or backwards, many of the branches having an inclination downwards.

The relations of the extra-pulmonary portions of the bronchi, which lie between the trachea and the lungs, cannot be completely studied at present. The intra-pulmonary relations are simple. *On the right side* the eparterial branch enters the upper lobe of the right lung accompanied by a branch of the superior right pulmonary vein and a branch of the right pulmonary artery. It breaks up in the substance of the upper lobe into numerous ramifications, all of which are accompanied by a corresponding pulmonary vein and artery. Below the eparterial branch the stem bronchus descends into the lower lobe, and as it descends it gives off a series of ventral and dorsal branches which arise alternately. Each branch is accompanied by a tributary of the pulmonary vein and a branch of the pulmonary artery. The first ventral branch is

distributed to the middle lobe. It is accompanied by a tributary of the superior pulmonary vein. All the other hyparterial branches are distributed to the lower lobe, and are accompanied by tributaries of the inferior pulmonary vein and branches of the pulmonary artery (Fig. 25).

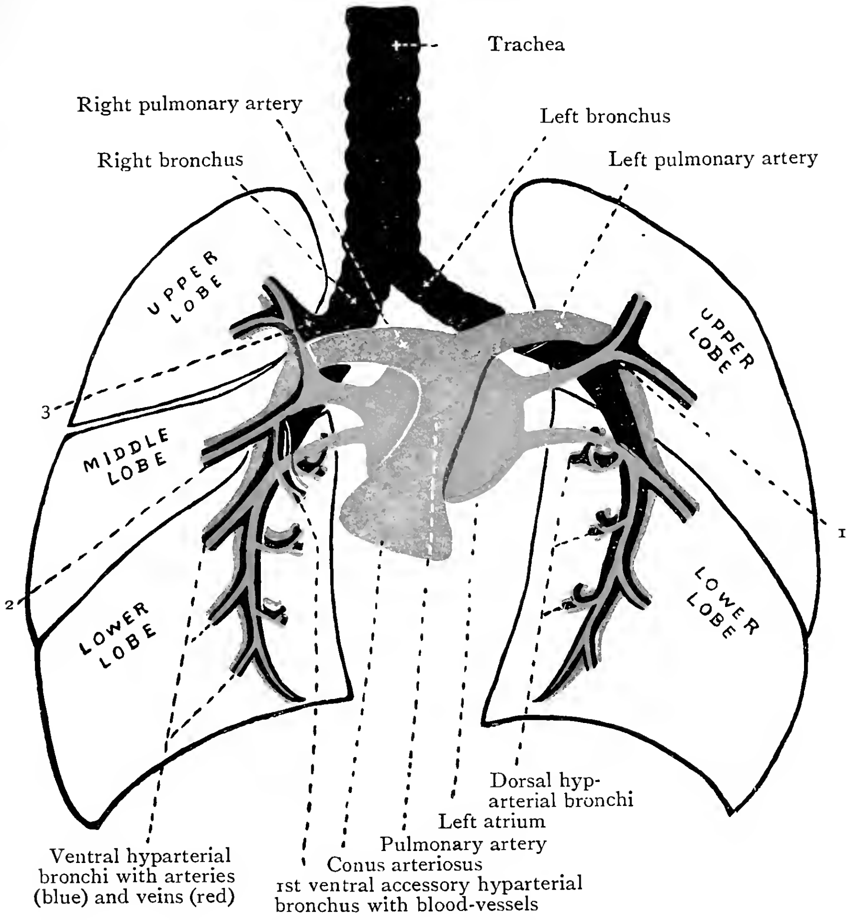

FIG. 25.—Diagram of the Lungs with the Bronchi and Blood-Vessels.

1. First left ventral hyparterial bronchus.
2. First right ventral hyparterial bronchus.
3. Eparterial bronchus.

All the bronchi, except the smallest terminal branches, are kept permanently open by bars and plates of cartilage, which lie in their walls and enable the bronchi to be so easily distinguished from the blood-vessels. Nevertheless the lumina of all the bronchi can be reduced in size by the contraction of the unstriped muscle fibres in their walls, for

none of the bars or plates of cartilage extend completely round the walls of the tubes.

In the left lung the arrangement of the bronchi differs from the arrangement in the right lung because in the left lung there is no eparterial branch. The first ventral hyparterial branch is distributed to the upper lobe, and is accompanied by a branch of the left pulmonary artery and by the upper left pulmonary vein. All the remaining branches are distributed to the lower lobe, and are accompanied by corresponding branches of the pulmonary artery and by tributaries of the lower left pulmonary vein.

Arteriæ Bronchiales.—As a rule, two bronchial arteries are distributed to the left lung and one to the right lung. The two left bronchial arteries spring from the descending aorta. The right bronchial artery is a branch either of the first right aortic intercostal artery or of the upper left bronchial artery. The bronchial arteries and their branches run along the posterior surfaces of the bronchi and their branches, and are the proper nutrient vessels of the lungs. Part of the blood which they convey to the lungs is returned by the pulmonary veins to the left atrium of the heart, but the remainder is returned by bronchial veins, which open on the right side into the vena azygos, and on the left side into the vena hemiazygos accessoria, or into the left superior intercostal vein.

Arteriæ Pulmonales.—One pulmonary artery is distributed to each lung. As it passes through the root of the lung it crosses anterior to the stem bronchus, and it descends in the interior of the lung, postero-lateral to the stem bronchus, and between its ventral and dorsal hyparterial branches. It gives off branches which correspond with and are distributed with the branches of the bronchus. When the bronchi terminate in the alveolar passages the final ramifications of the arteries terminate in capillaries which form a vascular network between the walls of the alveoli. The pulmonary arteries carry venous (de-oxygenated and carbonic acid laden) blood from the right ventricle of the heart to the lungs, where, as the blood runs through the capillaries between the walls of the alveoli, it gives off its excess of carbonic acid to and receives oxygen from the air in the alveoli.

Venæ Pulmonales.—As a rule there are four pulmonary veins — upper and lower, on each side. Variations are,

however, not uncommon, and the number may be increased to five, three on the right—one from each lobe of the right lung—and two on the left. On the contrary the number may be reduced to two—one on each side.

The pulmonary veins commence in the capillary plexuses between the walls of the alveoli; they accompany the bronchi, lying, as a rule, along their anterior faces, and they gradually unite together until on each side a terminal venous stem is formed in each lobe. The stems from the upper and middle lobes on the right side fuse together to form the upper right pulmonary vein. On the left side the stem from the upper of the two lobes forms the upper left pulmonary vein. On both sides the stem from the lower lobe is the lower left pulmonary vein.

The pulmonary veins carry arterial (oxygenated) blood from the lungs to the left atrium of the heart, whence it passes to the left ventricle and is then distributed to all the tissues of the body.

Vasa Lymphatica Pulmonum et Lymphoglandulæ Pulmonales et Bronchiales.—The lymph vessels of the lungs cannot be displayed in an ordinary "part," but the bronchial lymph glands, on account of their blackness and the dense fibrous tissue which binds them to the adjacent bronchi and blood-vessels, are disagreeably obvious, for they considerably increase the difficulties of the dissector who is attempting to clean the constituent parts of the root of the lung and the bronchi.

The lymph vessels of the lung convey lymph from the substance of the lung to the pulmonary lymph glands, which lie in the substance of the lung in the angles between the branches of the bronchial tubes. Having passed through the pulmonary lymph glands the lymph is carried onwards, by their efferent vessels, to the *broncho-pulmonary lymph glands*, which lie in the hilum of the corresponding lung in the angles between the stem and the highest branches of the bronchus. The broncho-pulmonary lymph glands also receive lymph directly from the visceral pleura. From the broncho-pulmonary lymph glands the lymph passes to the *tracheo-bronchial lymph glands*, which lie in the angle between the bronchus and the trachea on the lateral side; and to the *inter-tracheo-bronchial lymph glands*, which are placed in the angle between the two bronchi below the trachea. The latter

glands receive lymph from both lungs. The tracheo-bronchial glands are connected with both the anterior and posterior mediastinal glands by inter-communicating lymph vessels. From the right tracheo-bronchial glands the greater part of the lymph passes through the broncho-mediastinal trunk to the right lymph duct, and so to the right innominate vein, but some is carried to the right inferior deep cervical glands, which lie at the root of the neck behind the sterno-mastoid muscle. The lymph from the left tracheo-bronchial glands flows to the thoracic duct and the left inferior deep cervical glands. The lymph from the inter-tracheo-bronchial glands

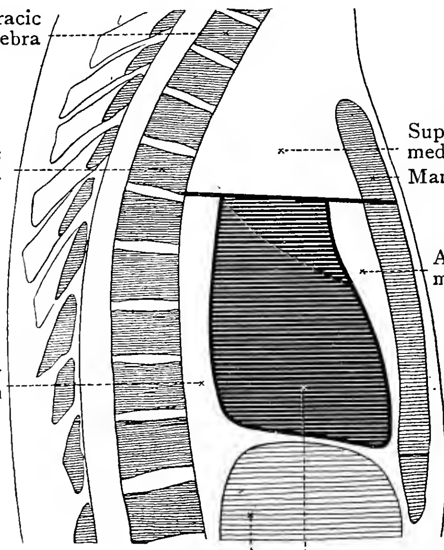

FIG. 26.—Diagram of the Mediastina.

flows partly to the broncho-mediastinal trunk and partly to the thoracic ducts.

The pulmonary, the broncho-pulmonary, and some of the tracheo-bronchial lymph glands were seen as the root of the lung and the bronchi were dissected. The remaining tracheo-bronchial and the inter-tracheo-bronchial lymph glands cannot be displayed until after the heart has been dissected (see p. 136).

The Mediastinum and its Contents.—It has been pointed out already that the mediastinum is the region which extends from the sternum to the vertebral column between the two pleural sacs; that it is occupied by some of the

most important viscera, vessels and nerves in the body, *i.e.*, the heart, enclosed in the pericardium; the aorta and its great branches; the great vessels which carry the blood to and from the heart; the œsophagus and trachea; the

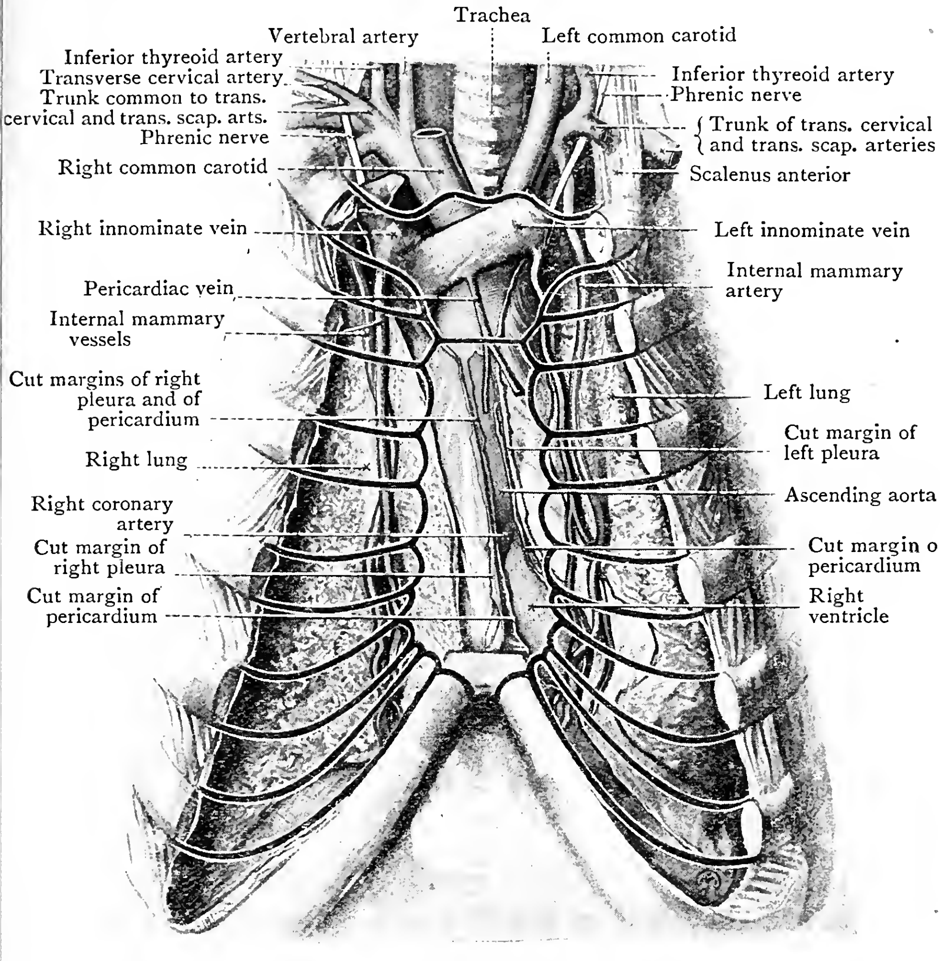

FIG. 27.—Dissection of the Anterior Part of the Thorax. The sternum and costal cartilages were replaced in position after the dissection had been made. The right scalenus anterior is cut away from its insertion up to the level of the upper border of the subclavian artery.

vagi and phrenic nerves; and the thoracic duct. It was noted further that the mediastinum is separated, for descriptive purposes, into two main parts, the *superior* and the *inferior mediastinum*, by an imaginary plane which passes from the lower border of the manubrium anteriorly to the lower border of the fourth thoracic vertebra posteriorly; it has

been noted also that the inferior mediastinum is separable into three parts: (1) the *anterior mediastinum*, anterior to the pericardium, (2) the *posterior mediastinum*, posterior to the pericardium, and (3) the *middle mediastinum*, occupied by the pericardium, the heart, the great vessels immediately adjacent to the heart, and portions of the phrenic nerves, with their accompanying vessels. These sections of the mediastinum and their contents must now be examined in detail.

Dissection.—The remains of the superior and anterior mediastinal parts of the pleura must be divided longitudinally, immediately posterior to the sternum, from the lower end of the thorax to the apices of the pleural sacs. The sternal extremities of the first ribs must be then cut through, close to the manubrium sterni, and, at the same time, the sternal heads of the sterno-mastoid muscles must be separated from the manubrium, if that has not already been done by the dissector of the head and neck. After the sterno-mastoid muscles and the first ribs are divided, the sterno-hyoid and sterno-thyreoid muscles must be cut through transversely, as close to the upper margin of the manubrium as possible. Next, the body of the sternum must be separated from the xiphoid process and the tips of the seventh costal cartilages. The sternum with the attached costal cartilages may then be removed and placed aside, but it must be carefully preserved for future use.

When the sternum is removed the mediastinum is exposed from the front. As seen from the front, the superior mediastinum, which lies posterior to the manubrium, is a relatively wide triangular area, with its apex below. The anterior mediastinum, on the other hand, is merely a narrow cleft between the adjacent anterior margins of the pleural sacs, except opposite the anterior end of the left fifth costal cartilage, where the left pleural sac deviates slightly to the left and the anterior mediastinum becomes slightly wider (Fig. 27).

The anterior parts of both the superior and the anterior mediastina are occupied by areolar tissue in which, as far down as the third or fourth costal cartilages, remains of the thymus may be found. It may be recognised by its position and by the relative firmness of its substance (Figs. 22, 23).

Thymus.—The thymus is a bilobed organ, developed from the third visceral pouches. It is well developed in the fœtus and in the child until the end of the second year. Then it frequently undergoes atrophy, but it may persist even until old age.

Dissection.—Remove the thymus and the remains of the mediastinal pleura and clean the anterior contents of the superior mediastinum and the pericardium. Commence with the right innominate vein and trace it from the upper aperture of the thorax to its termination in the superior vena cava. It is joined at its commencement, in the angle between the internal jugular

and subclavian veins, by the right lymph duct; posteriorly by the vertebral vein, and a vein from the first intercostal space; anteriorly, by the internal mammary vein and sometimes on its medial side by the right inferior thyreoid vein. Identify and clean as many of these tributaries as possible. Next clean the longer left innominate vein, which passes obliquely across the superior mediastinum along the upper margin of the aortic arch. Joining it at its commencement in the angle between the left internal jugular vein and left subclavian vein is the thoracic duct. The left inferior thyreoid vein enters its upper border. The left vertebral vein and a vein from the first left intercostal join it posteriorly near its commencement. The left superior intercostal vein, the left internal mammary vein, and some small pericardiac and thymic tributaries enter its lower border. The internal mammary and superior intercostal veins have already been identified (see pp. 15, 42); the others should now be secured if possible and all should be cleaned.

Not uncommonly the right and left inferior thyreoid veins unite at the root of the neck to form a common trunk which terminates frequently in the left innominate vein, but it may end in the junction of the two innominate veins or in the right innominate vein.

Venæ Anonymæ.—The innominate vein of each side is formed, posterior to the sternal end of the corresponding clavicle, by the union of the internal jugular and subclavian veins of the same side; and it ends, at the lower border of the right first costal cartilage, by uniting with its fellow of the opposite side to form the superior vena cava.

The *right innominate vein* is short and its course is almost vertical (Figs. 15, 27). It is accompanied on its medial side by the innominate artery, on its lateral side by the right phrenic nerve, and posteriorly by the right vagus nerve (Figs. 22, 23, 29). Antero-laterally it is in relation in the thorax with the anterior margin of the right pleura.

The *left innominate vein* is much longer than the right. It passes obliquely to the right and downwards, posterior to the upper half of the manubrium sterni; it lies posterior to the remains of the thymus and the lower ends of the sterno-hyoid and sterno-thyreoid muscles, and anterior to the three great branches of the aortic arch and the left phrenic and vagus nerves (Figs. 22, 27, 29).

Tributaries.—(1) The internal jugular vein, (2) the subclavian vein, (3) the vertebral vein, (4) the internal mammary vein, (5) the highest intercostal vein, and frequently (6) the inferior thyreoid vein of the same side. In addition, the right innominate vein receives the right lymph duct, or lymph vessels from the head and neck, the upper extremity and the right

half of the thorax of the same side; and the left innominate vein receives (*a*) the left superior intercostal vein, (*b*) some pericardiac and thymic veins, and (*c*) the thoracic duct.

Dissection.—After the innominate veins and their tributaries have been cleaned displace the left innominate upwards

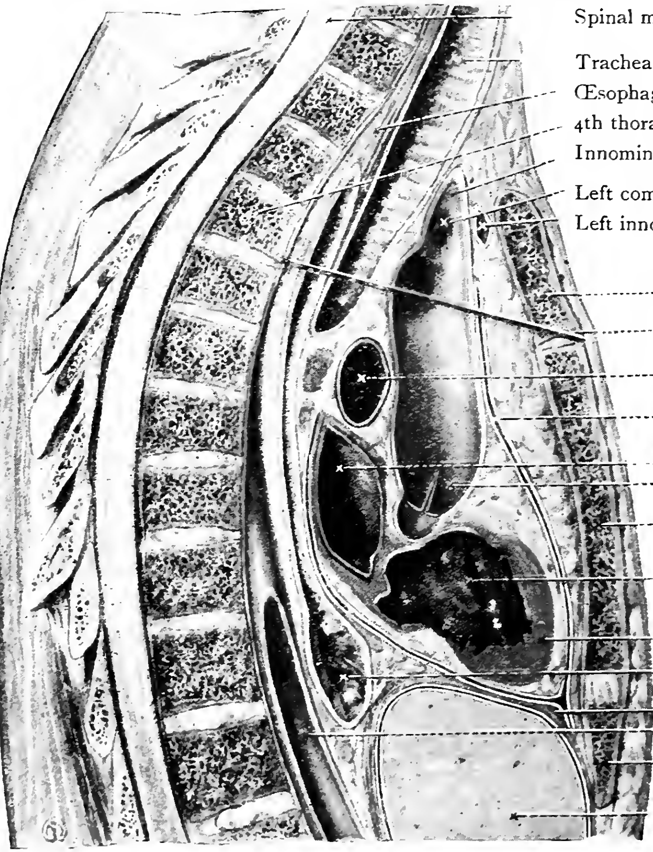

FIG. 28.—Sagittal section of the Thorax of an old man. The upper border of the manubrium sterni and the bifurcation of the trachea are lower than in the average adult.

or downwards, or divide it, as may be necessary, and clean the innominate artery from its origin from the arch of the aorta to its bifurcation into the right subclavian and right common carotid arteries. Next clean the left common carotid artery and the left subclavian artery, taking care not to injure the four nerves which descend between them, viz., the left phrenic nerve, the inferior cervical cardiac branch of the left vagus, the superior cervical cardiac branch of the left sympathetic trunk and the left vagus nerve, all of which have been identified in an earlier dissection (p. 35). When the three large branches of the arch

of the aorta have been cleaned, clean the arch itself. Then carefully remove the areolar tissue which lies between the innominate and left common carotid arteries and display the anterior surface of the trachea. Occasionally a small artery, the *thyreoidea ima*, will be found ascending on the front of the trachea. It springs either from the arch of the aorta or from the innominate artery. Lastly, clean the areolar tissue from the anterior surface of the pericardium, and then proceed to the study of the structures exposed.

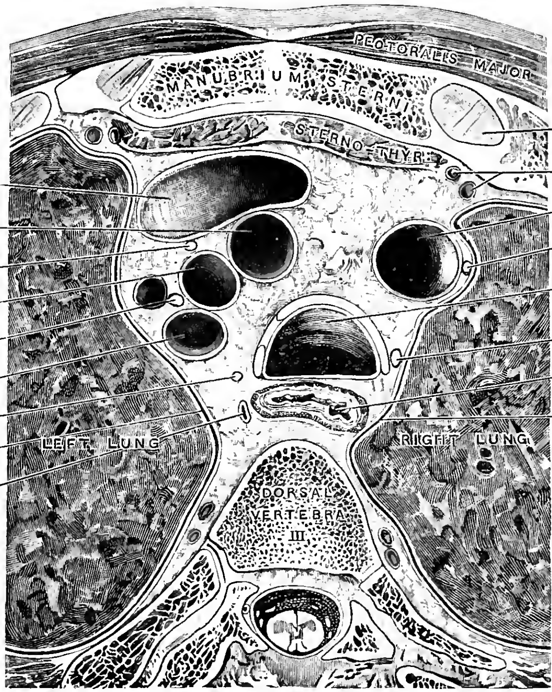

FIG. 29.—Transverse section through the Superior Mediastinum at level of the third thoracic vertebra.

Arteria Anonyma.—The innominate artery is the largest of the three great branches of the aortic arch. It commences, from the upper border of the arch, posterior and somewhat to the left of the centre of the manubrium sterni (Fig. 30), passes upwards and to the right, and terminates, posterior to the upper border of the right sterno-clavicular articulation, by dividing into the right common carotid and the right subclavian arteries (Fig. 27). Anterior to it are the manubrium sterni, with the attachments of the sterno-hyoid and thyreoid muscles, the right sterno-clavicular joint, the remains of the thymus, and the left innominate vein.

Posterior to its lower part is the trachea (Figs. 28, 29), but as the artery passes upwards and to the right it gains the side of the trachea and has the upper part of the right lung and pleura posterior to it. To its left, at its commencement, is the left common carotid artery, and at a

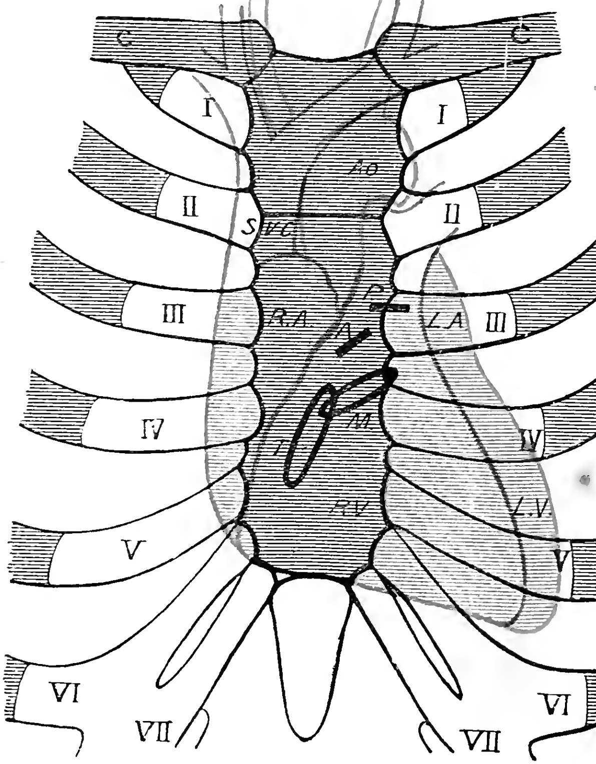

FIG. 30.—The relations of the Heart and of its Orifices to the Anterior Thoracic Wall.

I to VII. Costal cartilages.	M. Mitral orifice.
A. Aortic orifice.	P. Pulmonary orifice.
Ao. Arch of Aorta.	RA. Right atrium.
C. Clavicle.	RV. Right ventricle.
LA. Left atrium.	SVc. Superior vena cava.
LV. Left ventricle.	T. Tricuspid orifice.

higher level the trachea. On its right side is the right innominate vein, which separates it from the right phrenic nerve and the pleura. As a rule it gives off its terminal branches only, but occasionally a small artery, called the *thyreoidea ima*, springs from it.

Arteria Thyreoidea Ima.—This artery is frequently absent. When it is present it springs from the innominate artery, or from the arch of the aorta, and runs upwards, anterior to the trachea, to the thyreoid gland.

Arteria Carotis Communis Sinistra.—The left common carotid artery springs from the arch of the aorta, immediately to the left of, and slightly posterior to, the innominate artery. It passes upwards, through the superior mediastinum and posterior to the left sterno-clavicular joint, into the neck. Its *anterior relations* in the thorax are similar to those of the innominate artery. *Posterior to it*, from below upwards, are the trachea, the left recurrent nerve, the œsophagus and the thoracic duct, and, in a plane somewhat more to the left, the left phrenic and vagus nerves, and the left subclavian artery. *To its right* lie first the innominate artery, and then the trachea; and *to its left* is the left pleura. It gives off no branches in the thorax.

Arteria Subclavia Sinistra.—The left subclavian artery springs from the posterior part of the aortic arch, posterior to the left common carotid. It passes vertically upwards, through the superior mediastinum and posterior to the sternal end of the clavicle, into the root of the neck. *Anterior to it* are the left phrenic and vagus nerves, which separate it from the left common carotid artery. *Posterior*, and to its left side, it is in relation with the left mediastinal pleura and the lung. *To its right* side are the trachea and the left recurrent nerve, and, at a higher level, the œsophagus and the thoracic duct. It gives off no branches in the thoracic part of its course (Figs. 22, 29).

Dissection.—The lateral walls of the pericardium have already been exposed and opened (see p. 44); the flaps then made should be replaced and fixed in position with sutures. When that has been done, the outline of the sac will be fully displayed, and the dissectors can then study its relations to adjacent organs.

The Pericardium.—The pericardium is a fibro-serous sac which lies in the middle mediastinum. It surrounds the heart and the roots of the great vessels which enter and leave the heart.

The Fibrous Pericardium.—The fibrous or outer part of the pericardium is conical in form. *Its base* rests upon the diaphragm, principally upon the central tendon but also upon the muscular portion, particularly upon the left side. Near the median plane it is blended with the central tendon, and can be separated from it only by the aid of the edge of the scalpel; more laterally the areolar tissue which

connects the pericardium and the diaphragm can be easily broken down by the use of the handle of the knife. The diaphragm separates the pericardium mainly from the upper surface of the liver, but also, towards the left and anteriorly, from the fundus of the stomach. *The apex* of the fibrous sac

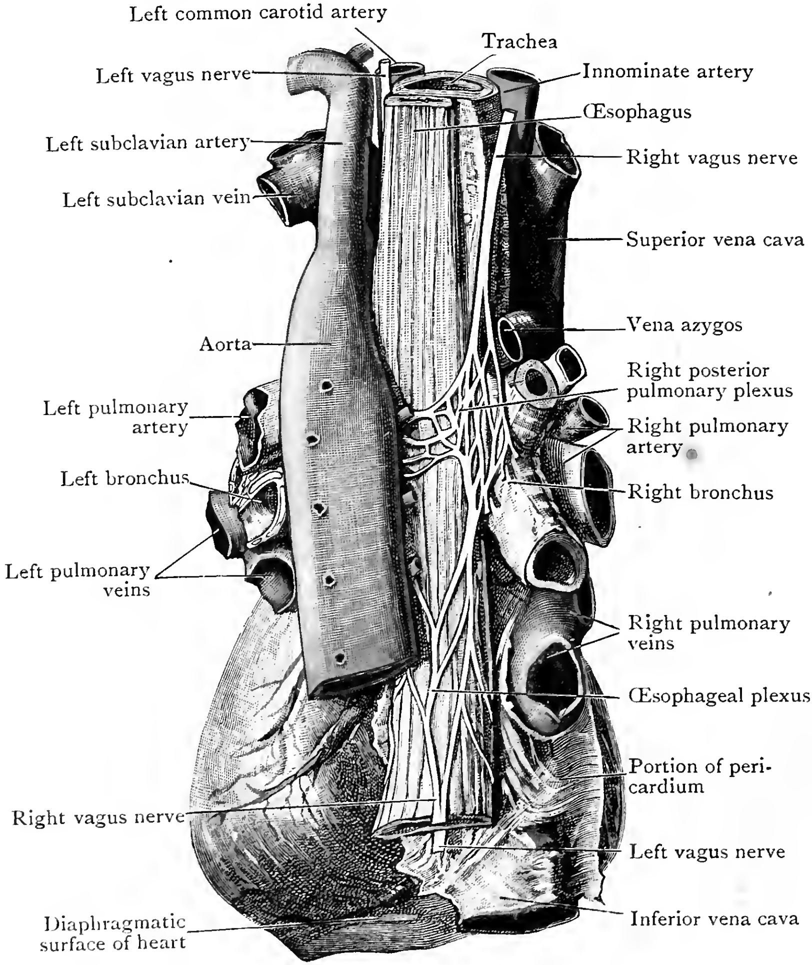

FIG. 31.—Posterior Aspect of the Heart, with the Descending Aorta, the Trachea and Bronchi, and the Œsophagus.

blends with the outer coats of the aorta, the pulmonary arteries and the superior vena cava. The *anterior surface* lies behind the body of the sternum and the cartilages of the ribs from the second to the sixth inclusive, but it is separated from them by the lungs and pleuræ, except (1) in the median plane of the anterior mediastinum, where condensations of the

areolar tissue of the mediastinum, called the superior and inferior *sterno-pericardiac ligaments*, connect the anterior surface of the fibrous sac to the upper and lower ends of the body of the sternum respectively, and (2) in the region of the sternal extremity of the left fifth costal cartilage, where the left pleura retreats somewhat towards the left side, and the pericardium comes into direct relation with the sternum and the left transversus thoracis muscle. That portion of the pericardium is the so-called *bare area.* It is usually of small extent, and frequently it does not extend beyond the margin of the sternum, but it is of importance because through it the surgeon may attempt to tap the pericardium when the sac is distended with fluid.

Each *lateral wall* of the pericardium is in relation with the corresponding mediastinal pleura, the phrenic nerve and the pericardiaco-phrenic vessels intervening (O.T. comes nervi phrenici). The *posterior surface* lies anterior to the descending aorta and the œsophagus medially, whilst laterally it is supported posteriorly by the lungs and pleuræ (Fig. 21). At the junction of the upper parts of the lateral and posterior surfaces, on each side, two pulmonary veins enter the pericardium and receive sheaths from its fibrous wall.

Dissection.—When the relations and prolongations of the fibrous pericardium have been studied, the two anterior flaps already made in the lateral walls of the sac (see p. 44) should be connected together and converted into one large anterior flap. This can be done by a transverse cut, passing across the median plane just above the diaphragm. The large triangular flap thus formed should be thrown upwards towards the apex of the pericardium.

The Serous Pericardium.—The serous pericardium is a closed and invaginated sac which lines the inner surface of the fibrous sac and envelops the heart and the roots of the great vessels passing to and from the heart.

The uninvaginated portion of the wall of the serous sac, which lines the inner surface of the fibrous sac, is called the *parietal layer*, and the invaginated portion, which envelops the heart and more or less covers the roots of the great vessels, is the *visceral portion.* The inner surface of the sac is lined by a flat endothelium, which, during health, is smooth and glistening. The parietal and visceral layers are separated, during health, merely by a thin layer of serous fluid, which prevents friction between the two surfaces as they move over

each other during the contractions and expansions of the heart.

The Sterno-costal Surface of the Heart.—Before the

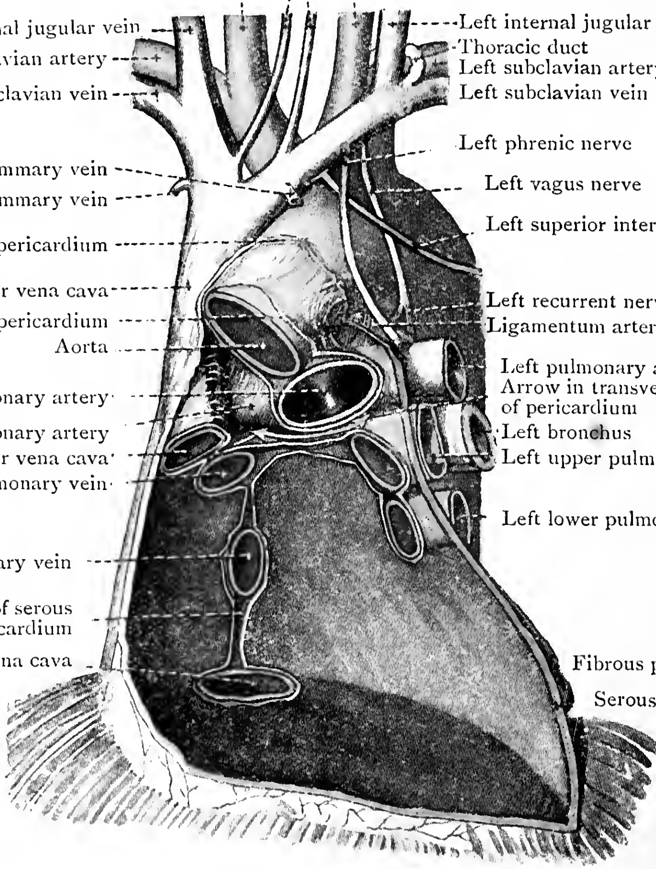

FIG. 32.—The Pericardium and Great Vessels of the Heart. The thoracic organs were hardened *in situ* by formalin injection. The pericardial cavity was opened by the removal of its anterior wall, the great vessels were divided and the heart was removed. The posterior wall of the oblique sinus is seen between the inferior vena cava and the right pulmonary veins on the right and the left pulmonary veins on the left.

dissectors disturb the heart, which has been exposed by the reflection of the anterior wall of the pericardium, they should note carefully not only the parts of the heart which are visible, but also their relations to the anterior wall of the thorax.

The latter they can easily do by replacing the sternum and costal cartilages in position from time to time.

They will find that the sterno-costal surface is divided into an upper and right, or atrial portion, and a lower and left, or ventricular portion by an oblique sulcus, called *the coronary sulcus* (O.T. *auriculo-ventricular*) (Figs. 33, 39), which is quite distinct below and on the right, but is masked above and to the left by the roots of the pulmonary artery and the aorta. The position of the coronary sulcus can be indicated on the surface of the body by a line extending obliquely downwards and to the right, from the sternal end of the third left to the sternal end of the sixth right costal cartilage. Below and to the left of the sulcus is the ventricular part of the sterno-costal surface, terminating on the left and below in the *apex* of the heart, which lies posterior to the fifth left intercostal space or to the left sixth rib, three and a half inches from the median plane. The ventricular area of the sterno-costal surface is divided by the anterior longitudinal sulcus (O.T. anterior interventricular sulcus) into a right two-thirds, formed by the right ventricle, and a left third, formed by the left ventricle. The anterior longitudinal sulcus terminates on the lower border of the sterno-costal surface, to the right of the apex, in a slight notch. The apex, therefore, is formed entirely by the left ventricle. The lower margin of the sterno-costal surface lies on the diaphragm. It is formed chiefly by the lower border of the right ventricle, and only to a small extent by the apical part of the left ventricle.

The upper and right portion of the sterno-costal surface is formed by the atria, which are to a large extent concealed by the pulmonary artery and the ascending part of the aorta. Above and to the right is the right atrium, continuous above with the superior vena cava and below with the inferior vena cava (Fig. 33), whilst its auricular portion (O.T. auricular appendage) curves upwards and to the left, along the line of the coronary sulcus, to the root of the pulmonary artery.

Crossing the front of the right atrium, immediately below the lower end of the superior vena cava, is a sulcus, called the *sulcus terminalis*. If the heart is pulled a little over to the left, this sulcus can be traced downwards, along the lateral aspect of the right atrium, to the anterior aspect of the upper end of the inferior vena cava. It indicates the separation between

the cavity of the atrium proper and the venous sinus of the atrium, into which the great veins open.

The whole of the right border of the heart is formed by the right atrium. Its position can be indicated on the surface

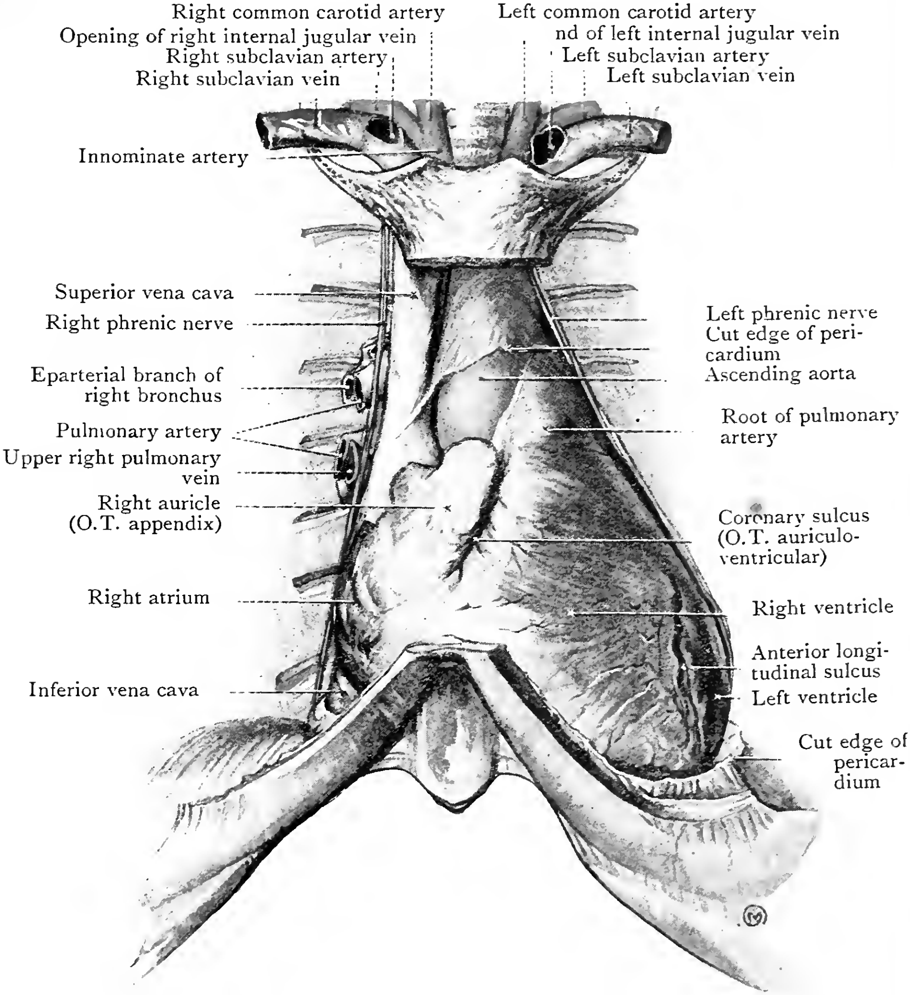

FIG. 33.—Dissection of the Middle and Superior Parts of the Mediastinum from the anterior aspect.

by a line, convex to the right, which commences at the level of the third right costal cartilage, half an inch from the sternum, and terminates opposite the sixth right cartilage at the same distance from the right margin of the sternum.[1] At

[1] When the right side of the heart is distended the lower end of the right border of the right atrium descends to the back of the seventh right costal cartilage.

the upper and left corner of the atrial area is the apex of the auricle of the left atrium (O.T. auricular appendage), and between the two auricles are the roots of the pulmonary artery and the aorta, the former anterior to the latter. The rounded portion of the upper part of the right ventricle, immediately below the pulmonary artery, is called the *conus arteriosus*.

If the pulmonary artery and the ascending part of the aorta were removed the upper parts of the anterior surfaces of the right and left atria, which lie behind the arteries, would be exposed, and the upper border of the heart, which is formed by the two atria, could be seen (Figs. 37). The two large vessels must not, however, be interfered with at present. Nevertheless, the dissectors should investigate the cleft which lies between the posterior surfaces of the arteries and the anterior surfaces of the atria. It is called the *transverse sinus of the pericardium* (Figs. 32, 37).

To find the transverse sinus pass a finger across the front of the lower part of the superior vena cava and behind the ascending aorta, then push it to the left until it emerges between the left side of the pulmonary artery and the auricle of the left atrium. The cleft through which the finger has passed is the transverse sinus. As the finger lies in the transverse sinus it has in front of it the ascending aorta and the stem of the pulmonary artery, which are enclosed in a common sheath of the visceral part of the serous pericardium, and form the anterior boundary of the transverse sinus. Behind the finger lie the upper parts of the right and left atria, which form the posterior wall of the sinus. Below the finger, at the lower border of the sinus, the visceral pericardium is reflected forwards from the anterior surface of the atria to the posterior surface of the ascending aorta. And above the finger, at the upper margin of the sinus is the inferior surface of the right pulmonary artery covered by the visceral pericardium as it passes forwards from the upper borders of the atria to the posterior surface of the ascending aorta. In Fig. 37 which represents a sagittal section of a heart, in which the transverse sinus is cut across at right angles to its long axis, the various boundaries of the sinus are in apposition with one another, but their relative positions are quite obvious.

Whilst a finger is kept in the transverse sinus a pointer

should be passed through the right and left pulmonary arteries. Introduce the pointer through the cut end of the right pulmonary artery, in the root of the right lung, and pass it to the left until it emerges from the cut end of the left pulmonary artery in the root of the left lung. The dissectors will note that, as the pointer traverses the pulmonary arteries, from right to left, it passes first posterior to the superior vena cava, and then along the upper border of the transverse sinus which runs parallel with the part of the upper border of the heart which is formed by the left atrium.

Leave the pointer which marks the levels of the right and left pulmonary arteries and the upper border of the heart in position, but withdraw the finger from the sinus. Now replace the sternum and costal cartilages and note that the pointer, which marks the position of the upper border of the heart, inclines slightly downwards, as it passes from left to right, along a line which extends from the lower border of the second left costal cartilage to the upper border of the third right costal cartilage. The position of the upper border of the heart can be indicated, therefore, on the anterior surface of the thorax by a line drawn from the lower border of the second left costal cartilage to the upper border of the third right costal cartilage, commencing and ending 13 mm. (about half an inch) from the margin of the sternum. The right two-thirds of the same line will indicate fairly correctly the position of the right pulmonary artery. The left third will similarly indicate the position of the medial part of the left pulmonary artery.

The left border of the anterior surface of the heart is formed, to a slight extent, by the left atrium, but mainly by the left ventricle. It is convex to the left and its position is marked, on the surface of the body, by a line which commences above at the lower border of the left second costal cartilage, half an inch from the sternum, and terminates below, at the apical point, in the fifth left intercostal space, or behind the left sixth costal cartilage.

Before proceeding further the dissector should summarise the information he has gained regarding the relationship of the apex of the heart and the borders of the sterno-costal surface of the heart to the anterior wall of the thorax.

The *upper border* is formed by the atria, and, as the heart lies *in situ*, it is concealed to a great extent by the aorta and

the pulmonary artery. Its position is marked on the surface by a line extending from the lower border of the second left to the upper border of the third right costal cartilage, commencing and terminating 13 mm. (about half an inch)

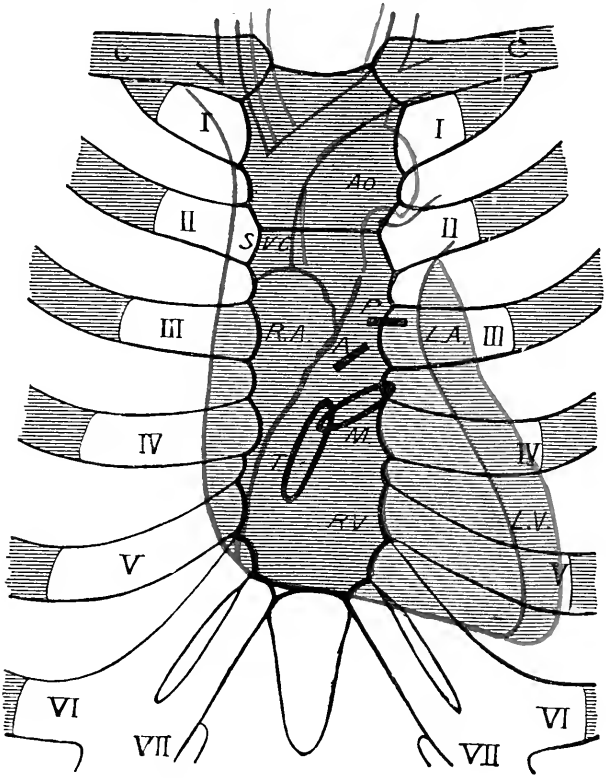

FIG. 34.—The relations of the Heart and of its Orifices to the Anterior Thoracic Wall. (Young and Robinson.)

I to VII. Costal cartilages.
A. Aorta.
Ao. Arch of Aorta.
C. Clavicle.
LA. Left atrium.
LV. Left ventricle.
M. Mitral orifice.
P. Pulmonary orifice.
RA. Right atrium.
RV. Right ventricle.
SVc. Superior vena cava.
T. Tricuspid orifice.

from the margins of the sternum. The *right border* is formed entirely by the right atrium, and its position is indicated on the surface by a line, convex to the right, commencing above at the upper border of the third right costal cartilage 13 mm. (half an inch) from the side of the sternum, and terminating below at the sixth right cartilage 13 mm. (half an inch) from

its junction with the sternum. More than two-thirds of the *lower border* are formed by the right ventricle, and the remainder by the apical portion of the left ventricle, and the two parts may be separated by a distinct notch. The lower border is slightly concave downwards, in correspondence with the upward convexity of the diaphragm on which it rests, and it has a slight inclination downwards and to the left. It is marked, on the surface of the body, by a line extending from the sixth right costal cartilage, near the sternum, to the apical point, which lies in the left fifth intercostal space, or behind the left sixth costal cartilage, from 80-85 mm. ($3\frac{1}{4}$ to $3\frac{1}{2}$ inches) from the median plane. The left border, which is formed mainly by the left ventricle and only to a slight extent by the left atrium, extends from the apex to a point on the lower border of the left second costal cartilage 13 mm. (half an inch) from the margin of the sternum (Figs. 33, 34, 35).

The coronary sulcus, which indicates the plane of union of the atria and ventricles and, therefore, the plane of the atrio-ventricular and aortic and pulmonary orifices of the heart, can be indicated, on the surface, by a line extending from the sternal end of the third left costal cartilage to the sternal end of the sixth right cartilage. Posterior to the left extremity of that line, at the level of the upper part of the third left costal cartilage, is the pulmonary orifice of the heart. The aortic orifice is a little lower and slightly to the right, posterior to the sternum at the level of the lower border of the third left cartilage. Immediately below the aortic orifice, posterior to the left margin of the sternum, at the level of the upper part of the fourth left cartilage, lies the mitral orifice; and the tricuspid orifice is situated posterior to the middle of the sternum, opposite the fourth intercostal spaces. The positions of the great orifices cannot be confirmed at this stage of the dissection, and they will be noted again, at a later period, when the heart is opened.

After the sterno-costal aspect of the heart, the boundaries of the transverse sinus, and the general position of the heart have been studied, the dissectors should turn the apex of the heart upwards and to the right, and examine the inferior and posterior surfaces whilst the heart is still *in situ*. They will find that the *inferior* or *diaphragmatic surface*, which rests upon the diaphragm, is slightly concave; that it is

PLATE I

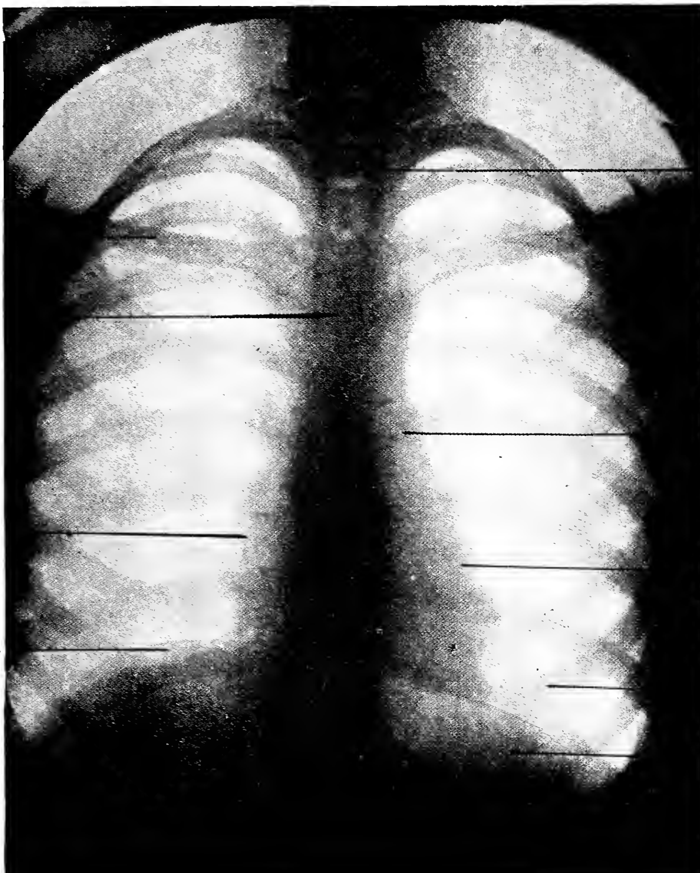

FIG. 35.—Radiograph of Thorax viewed from the front.
(Goldesbrough.)
Diaphragm in position of inspiration.

PLATE II

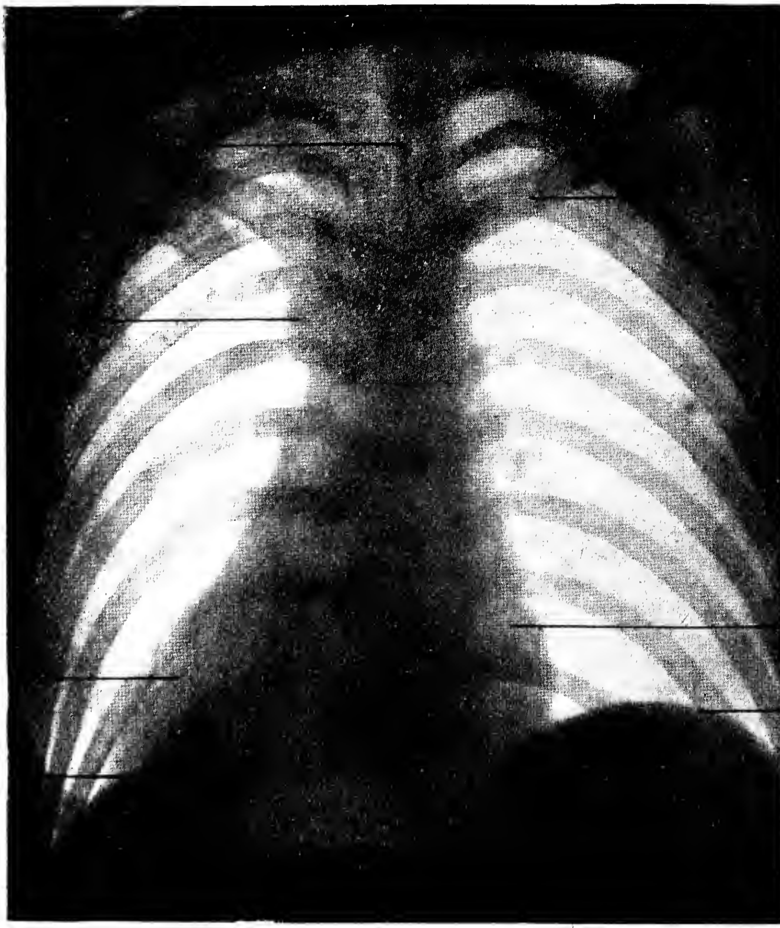

FIG. 36.—Radiograph of Thorax, seen from behind. (Goldesbrough.)

Diaphragm in position of expiration.

formed entirely by the ventricles, and mainly by the left ventricle, which forms the left two-thirds, the separation between the ventricles being indicated by the *inferior longitudinal sulcus.* As the apex of the heart is held upwards and to the right, the dissector should note that a recess of the pericardial cavity ascends behind the *base* or *posterior surface* of the heart. That recess is the *oblique sinus* of the

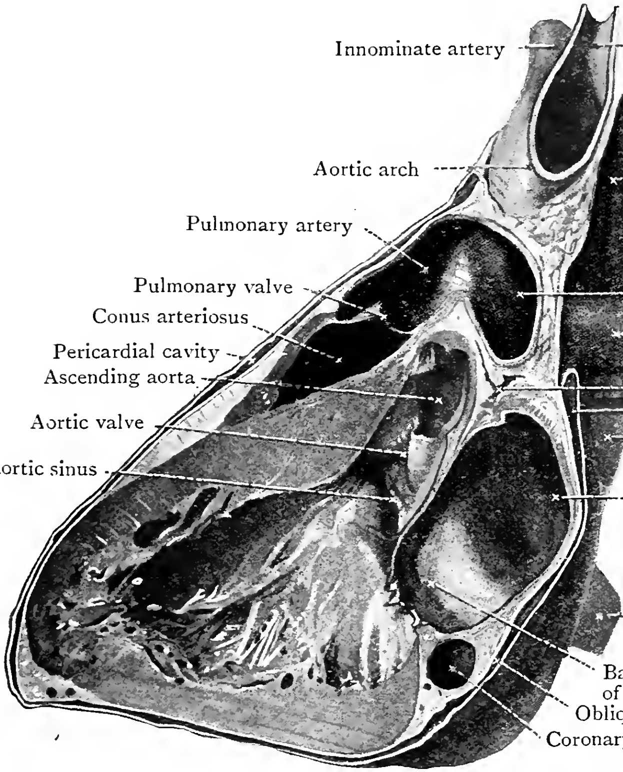

FIG. 37.—Sagittal section of Heart.

pericardium. Its orifice is below, where it is bounded to the right and below by the upper end of the inferior vena cava, and to the left and above by the inferior left pulmonary vein (Fig. 32). The posterior boundary of the sinus is the pericardium; and the pericardium separates the cavity of the sinus from the œsophagus, which, in this region, especially at its lower part, is lying between the pericardium and the descending part of the thoracic portion of the aorta. Both the œsophagus and the aorta can be palpated through

the posterior wall of the sinus. The anterior wall of the oblique sinus is the posterior wall of the left atrium (Fig. 37). If the dissector passes his left index finger into the transverse sinus and the middle and index fingers of his right hand into the oblique sinus, he will be able to convince himself that the left atrium is the only structure which intervenes between the cavities of the two sinuses. When he has satisfied himself regarding this point, he should note that the lower and posterior part of the coronary sulcus of the heart extends across the lower part of the base between the posterior end of the left ventricle and the lower end of the left atrium, and that it is occupied by the coronary blood sinus, which opens into the right atrium immediately to the left of the upper end of the inferior vena cava.

A complete examination of the base of the heart cannot be made until the heart is removed from the thorax at a later stage of the dissection, and the dissectors should pass now to a consideration of the relation of the serous layer of the pericardium to the great vessels which are entering or leaving the heart (see Fig. 32). They have previously noted (p. 73) that the visceral layer of the serous portion of the pericardium covers almost every portion of the heart, the only part left uncovered being the upper border of the left atrium, which is in contact with the lower border of the right pulmonary artery.

To demonstrate again the lines of reflection of the visceral into the parietal part of the serous pericardium, seize the apex of the heart with the left hand and lift it upwards. Then pass the fingers of the right hand along the visceral layer on the inferior surface of the heart and upwards along the posterior surface of the left atrium to the upper margin of the oblique sinus, where, immediately below the right pulmonary artery, the visceral layer passes backwards and joins the parietal layer on the inner surface of the posterior wall of the pericardium. Follow the parietal layer on the posterior wall of the pericardium downwards with the fingers. At the inferior end of the posterior wall they will be carried forwards on the inner surface of the inferior wall, or base, of the pericardium to the anterior wall, which should be temporarily replaced in position. Then they must pass upwards along the anterior wall, to the level of the upper parts of the ascending aorta and the pulmonary artery, where

the parietal layer of the serous pericardium is reflected from the fibrous layer of the pericardium on to the walls of the aorta and the pulmonary artery, and the fingers, following it, will pass downwards on the two great arteries and along the fronts of the ventricles to the inferior border of the anterior surface, so completing the circuit of the heart in the sagittal plane, and demonstrating that it is covered on the posterior, inferior and anterior surfaces by the serous layer of the pericardium.

It has been noted, previously, that the upper parts of the anterior surfaces of the atria are concealed by the ascending aorta and the stem of the pulmonary artery, from which they are separated by the transverse sinus. It must be noted now that the visceral layer of the serous pericardium which surrounds the cavity of the transverse sinus covers the posterior surfaces of the aorta and the stem of the pulmonary artery, that it passes backwards from them across the inferior surface of the right pulmonary artery and then downwards on the anterior surface of the left atrium. It is immediately behind the latter reflection that the upper border of the atrium is not covered by serous pericardium in the angle between the transverse sinus and the upper end of the oblique sinus. (See Fig. 59, in which the prolongation upwards of the fibrous layer of the pericardium on to the back of the right pulmonary artery has been removed.) The fact that a finger can be passed through the transverse sinus posterior to the aorta and the pulmonary artery, but that it cannot be insinuated between the two vessels, will indicate to the dissectors that the two great arteries are enclosed in a tubular sheath of the visceral part of the serous membrane.

An examination of the venæ cavæ will show that the lower inch of the superior vena cava lies within the fibrous pericardium and that it is ensheathed, except along its postero-medial border, by a covering of the serous layer, whilst the inferior vena cava can scarcely be said to have any intra-pericardial course, for it joins the lower and posterior part of the right atrium immediately after piercing the fibrous layer, but the margin of the orifice by which it enters is surrounded by the serous layer except along a narrow line posteriorly (Fig. 32). The left pulmonary veins are covered by the serous layer on their superior, anterior, and inferior aspects, but not posteriorly; and the right pulmonary veins, which enter the left atrium as

soon as they have pierced the fibrous pericardium, are in relation with the serous layer merely along the medial and lateral borders of the orifices in the fibrous layer through which they enter.

Dissection.—After the examination of the reflections of the serous layer of the pericardium is completed, the dissectors should study the vessels and nerves which supply the walls of the heart. They are the coronary arteries and the cardiac veins and nerves, and they lie in the coronary and longitudinal sulci of the heart, which have been noted already. To display them the visceral pericardium superficial to them must be cut and turned aside; the fat which lies in the sulci around the vessels must be removed; then the main vessels can be traced to their origins and terminations, and an endeavour should be made to preserve the fine nerves which accompany the vessels.

Arteriæ Coronariæ.—The coronary arteries are the nutrient vessels of the heart. They spring from dilatations of the commencement of the aorta which are called the *sinus aortæ* (Valsalva). There are three sinuses of the aorta, an anterior and two posterior, and only two coronary arteries, a right and a left; the right artery springs from the anterior sinus, and the left from the left posterior sinus (Figs. 20, 38).

The *right coronary artery* passes forwards from the anterior aortic sinus, between the pulmonary artery and the auricle of the right atrium; turns downwards and to the right, in the coronary sulcus, to the lower part of the right margin of the heart, round which it curves. Then it proceeds to the left, in the posterior part of the coronary sulcus, till it reaches the posterior end of the inferior longitudinal sulcus, where it divides into a small transverse and a large interventricular branch. The *transverse branch* continues to the left, in the coronary sulcus, till it anastomoses with the circumflex branch of the left coronary artery. The *interventricular branch* runs forwards in the inferior longitudinal sulcus on the diaphragmatic surface of the heart, and it anastomoses with the interventricular or descending branch of the left coronary artery at the cardiac notch on the lower margin of the heart. In addition to its terminal branches, the right coronary artery supplies branches to the roots of the pulmonary artery and the aorta, and to the walls of the right atrium and the right ventricle, the larger and more numerous branches being given to the ventricle. One of the latter, the *marginal branch*, passes along the inferior margin of the heart towards the apex of the ventricle (see Fig. 39).

The *left coronary artery* springs from the left posterior aortic sinus (Fig. 38). It lies, at first, posterior to the pulmonary artery, and runs towards the left for a short distance. Then it turns forwards, between the pulmonary artery and the auricle of the left atrium (Fig. 20), and divides into a descending or interventricular, and a circumflex branch.

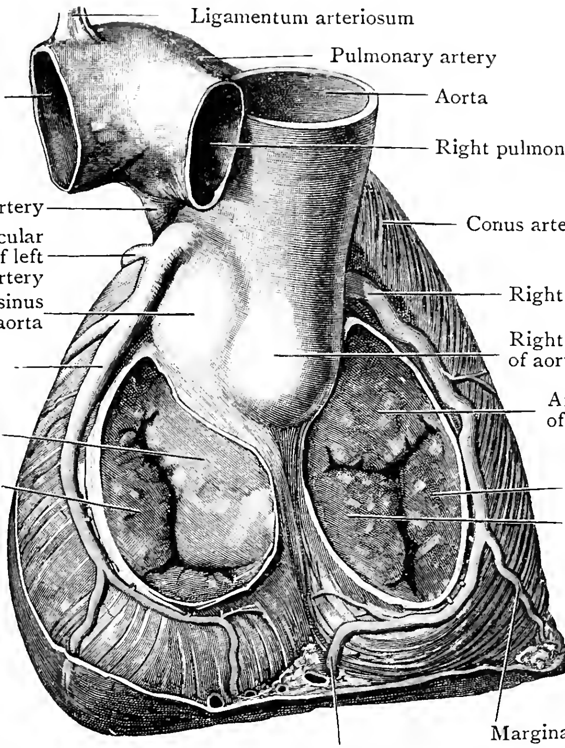

FIG. 38.—The Base of the Ventricular Part of the Heart, from which the Atria have been removed. The detached atria are depicted in Fig. 41. The specimen was hardened *in situ*.

The *interventricular branch* passes downwards along the sterno-costal surface of the heart, in the anterior longitudinal sulcus (Fig. 39), and, after turning round the lower border of the heart, in the cardiac notch, it anastomoses with the interventricular branch of the right coronary artery. The *circumflex branch* runs to the left, in the coronary sulcus, turns round the left border of the heart (Fig. 38), and anastomoses, in the posterior part of the coronary sulcus, with the transverse terminal branch of the right coronary artery.

From the stem of the left coronary artery twigs are given to the roots of the pulmonary artery and the aorta, and its terminal branches supply the walls of both ventricles and the walls of the left atrium.

The dissectors should note that the two coronary arteries are the only arteries which supply blood to the walls of the

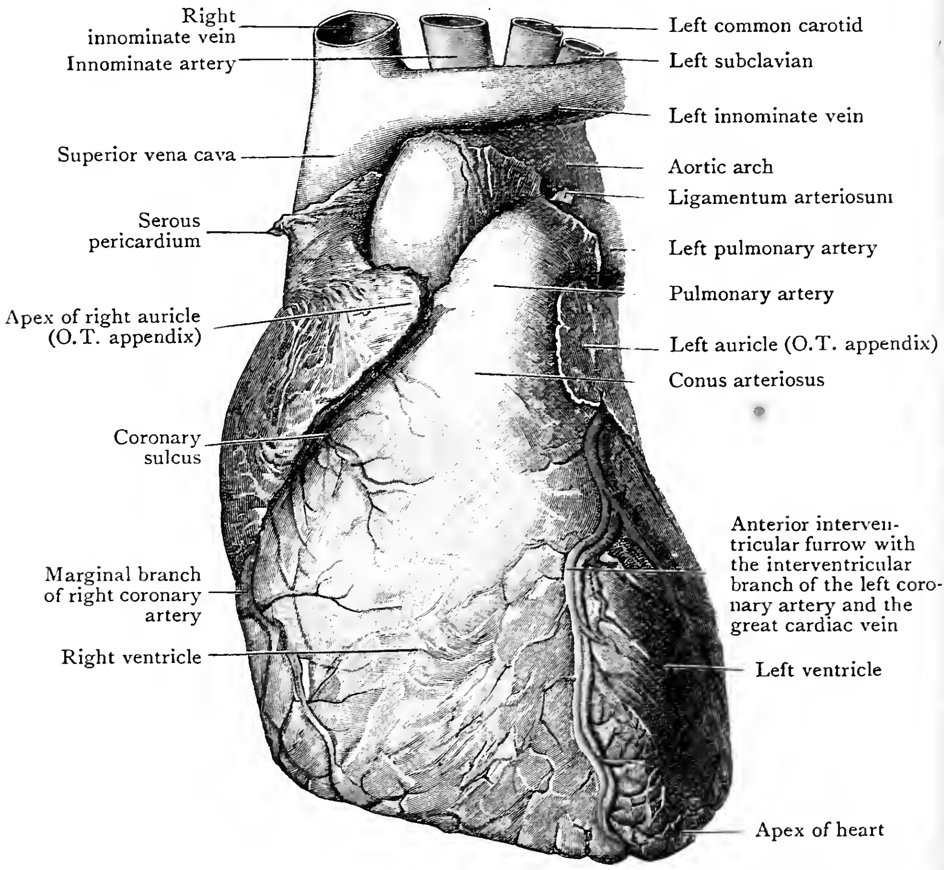

FIG. 39.—Sterno-costal Surface of the Heart.

heart, and that they form no effective anastomoses with any other arteries. Therefore, if they are obliterated, the blood supply to the walls of the heart is stopped and death must ensue. Occasionally there are three coronary arteries, one from each aortic sinus, and sometimes there is only one coronary artery, which may be either the right or the left.

Venæ Cordis.—The cardiac veins are: (1) the coronary sinus; (2) the great cardiac vein; (3) the inferior (posterior)

ventricular vein; (4) the middle cardiac vein; (5) the oblique vein; (6) the small cardiac vein; (7) the anterior cardiac veins; and (8) the venæ cordis minimæ.

The *coronary sinus* lies at the base of the heart, in the posterior part of the coronary sulcus, between the inferior border of the left atrium and the posterior border of the left ventricle. It can be displayed when the apex of the heart is turned upwards and to the right. Its right extremity opens into the right atrium, immediately to the left of the orifice of the inferior vena cava (Figs. 41, 44). At its left

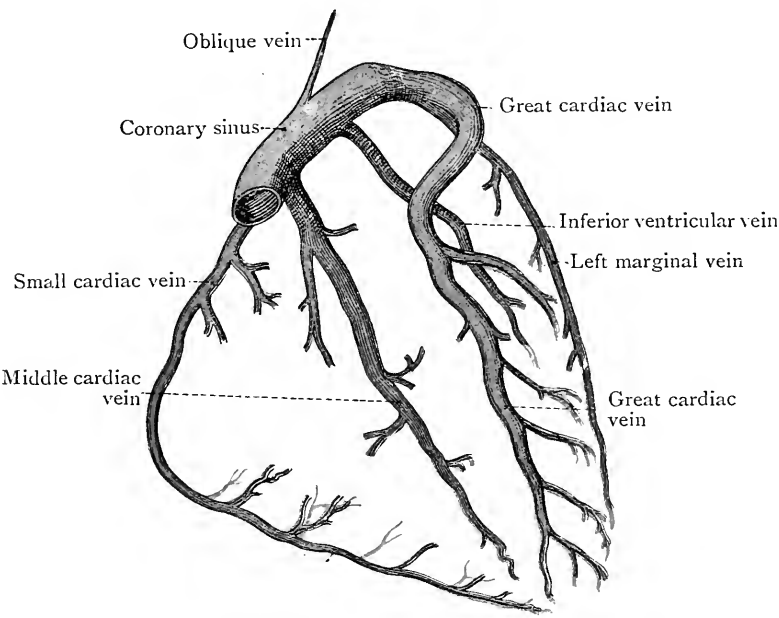

FIG. 40.—The Coronary System of Veins on the Surface of the Heart. (Diagram.)

extremity it receives the great cardiac vein. The *great cardiac vein* ascends along the anterior longitudinal sulcus (Fig. 39), where it lies in relation with the interventricular branch of the left coronary artery. At the upper end of the interventricular sulcus it turns round the left border of the heart, with the circumflex branch of the left coronary artery, and it ends in the left extremity of the coronary sinus. The *inferior ventricular vein* or veins, from the diaphragmatic surface of the left ventricle, and the *middle cardiac vein*, which runs backwards in the inferior longitudinal sulcus, end in the

lower border of the coronary sinus. The *oblique vein* descends on the posterior wall of the left atrium and ends in the upper border of the coronary sinus. The *small cardiac vein* (O.T. *right coronary*) runs along the lower margin of the heart with the marginal branch of the right coronary artery,

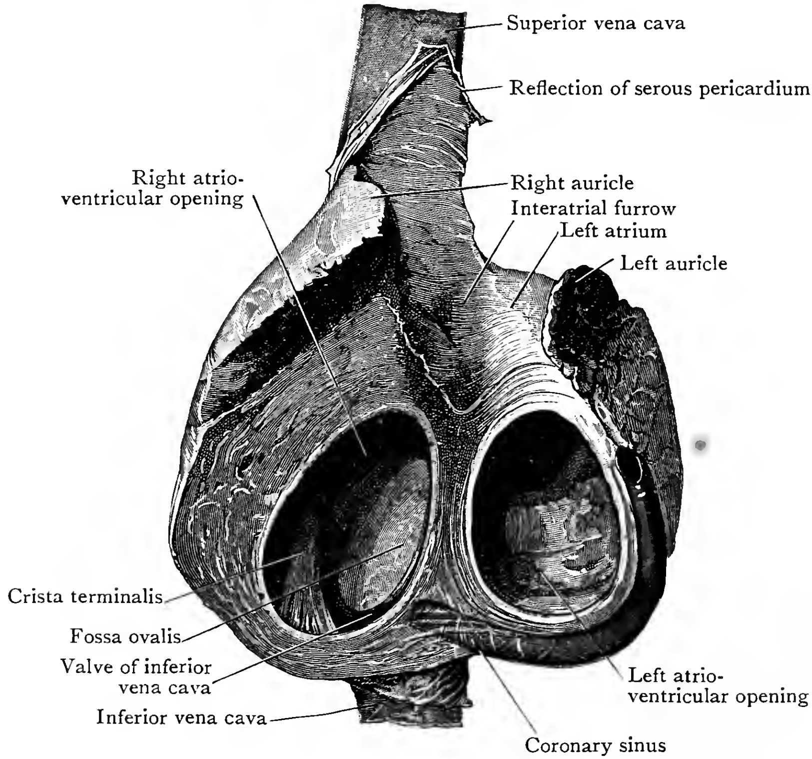

FIG. 41.—The Anterior Aspect of the Atrial Part of the Heart. The atria have been removed from the ventricles. The ventricular portion of the same heart is depicted in Fig. 38. The specimen was hardened *in situ*.

curves round the right border of the heart, in the coronary sulcus, and ends in the right extremity of the coronary sinus.

The *anterior cardiac veins* are small vessels which ascend along the anterior surface of the right ventricle and terminate directly in the lower and anterior part of the right atrium. The *venæ cordis minimæ* are small veins which pass from the substance of the heart, and more particularly from the walls of the right atrium and ventricle, and open, by small orifices, into the cavity of the right atrium. The orifice through which the great cardiac vein opens into the coronary sinus is

usually provided with a valve; the orifice of the small cardiac vein may be provided with a valve, but the orifices of the other tributaries of the sinus are generally devoid of valves.

Nervi Cordis.—The coronary plexuses, from which the nerves of the heart are directly derived, are offshoots of the superficial and deep cardiac plexuses. The superficial cardiac plexus has already been investigated (p. 56). It lies below the arch of the aorta and above the bifurcation of the pulmonary artery, at the right side of the ligamentum arteriosum. The deep cardiac plexus, which is situated between the posterior surface of the arch of the aorta and the front of the bifurcation of the trachea, will be dissected later (p. 129).

The *right coronary plexus* is formed by twigs from the superficial cardiac plexus which descend along the pulmonary artery, and by additional fibres from the deep cardiac plexus. It is distributed along the course of the right coronary artery. The *left coronary plexus*, which accompanies the artery of the same name, is derived from the deep cardiac plexus. The nerves do not slavishly follow the arteries; they soon leave the vessels, and are ultimately lost in the substance of the heart. Here and there ganglia are developed in connection with them.

Dissection.—The chambers of the heart and the great vessels which communicate with them should now be examined, as far as possible, whilst the heart is still *in situ*, so that the relations of the various orifices to the sternum and costal cartilages can be verified. Examine first the right atrium and the venæ cavæ, then the right ventricle and the pulmonary artery, and afterwards the left ventricle and the ascending part of the aorta, which springs from it. The examination of the left atrium, and the terminations of the pulmonary veins, cannot be conveniently undertaken until the heart and the pericardium have been removed from the body (see p. 119).

Open the *right atrium* by means of the following incision. Enter the knife at the apex of the auricle of the atrium (O.T. auricular appendix) and carry it backwards, close to the upper border of the auricle, across the sulcus terminalis and through the lateral wall of the atrium, to the posterior border of the lower end of the superior vena cava; then downwards, posterior to the sulcus terminalis, to the inferior vena cava; and, finally, forwards, across the lower end of the sulcus terminalis and above the anterior aspect of the upper end of the inferior vena cava, to the coronary sulcus. Throw the flap thus formed forwards, and clean the interior of the cavity with a sponge.

Atrium Dextrum (O.T. **Right Auricle**).—As the flap

formed by the anterior and lateral walls of the right atrium is turned forwards a vertical ridge will be noted on its inner surface. It is the *crista terminalis*, which corresponds in position with the sulcus terminalis on the outer surface. It marks the boundary between the anterior part of the atrium, the *atrium proper*, and the posterior part, which

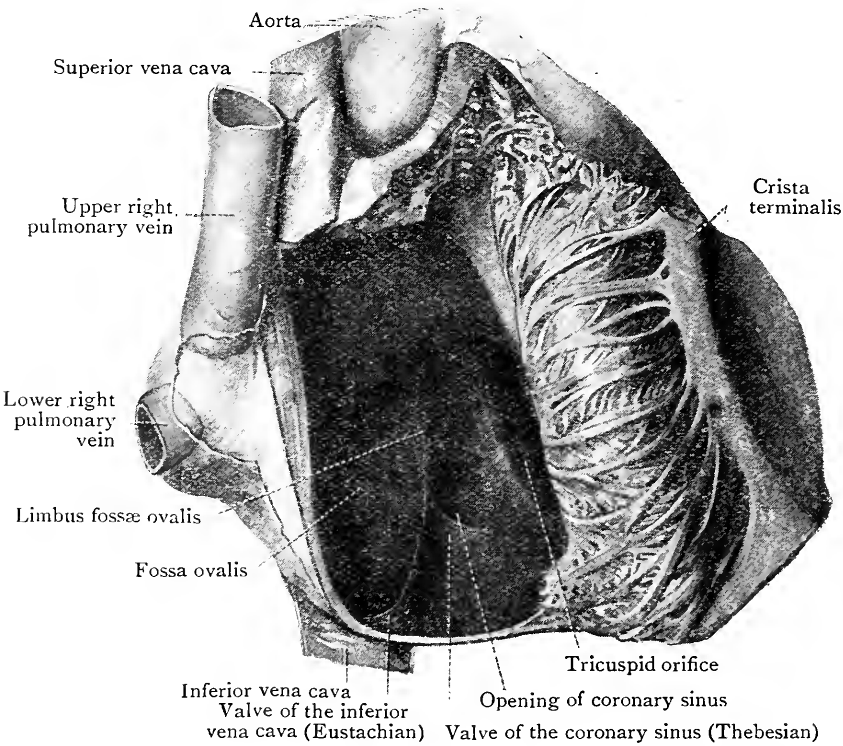

FIG. 42.—The Right Atrium. Part of the posterior wall and the whole of the right lateral and anterior walls have been turned forwards.

is known as the *sinus venarum* because the great veins of the body and heart open into it (Figs. 42, 43). The two parts of the cavity differ, however, not only in position and their relations to the great veins, but also in the characters of their walls. The whole of the interior of the atrium presents a polished glossy appearance, due to the endocardial lining; but, whilst the wall of the sinus venarum is smooth, the rest of the wall of the atrium is rendered rugose by a large number of muscular ridges which commence at the crista terminalis and run forwards to the right margin of the

atrium. The muscular ridges, on account of their somewhat parallel arrangement, are called the *musculi pectinati*.

The veins which open into the right atrium are the (1) superior vena cava, (2) inferior vena cava, (3) coronary sinus, (4) anterior cardiac veins, and (5) venæ cordis minimæ. The aperture by which the blood leaves it is the tricuspid orifice.

The *orifice of the superior vena cava* is in the upper and

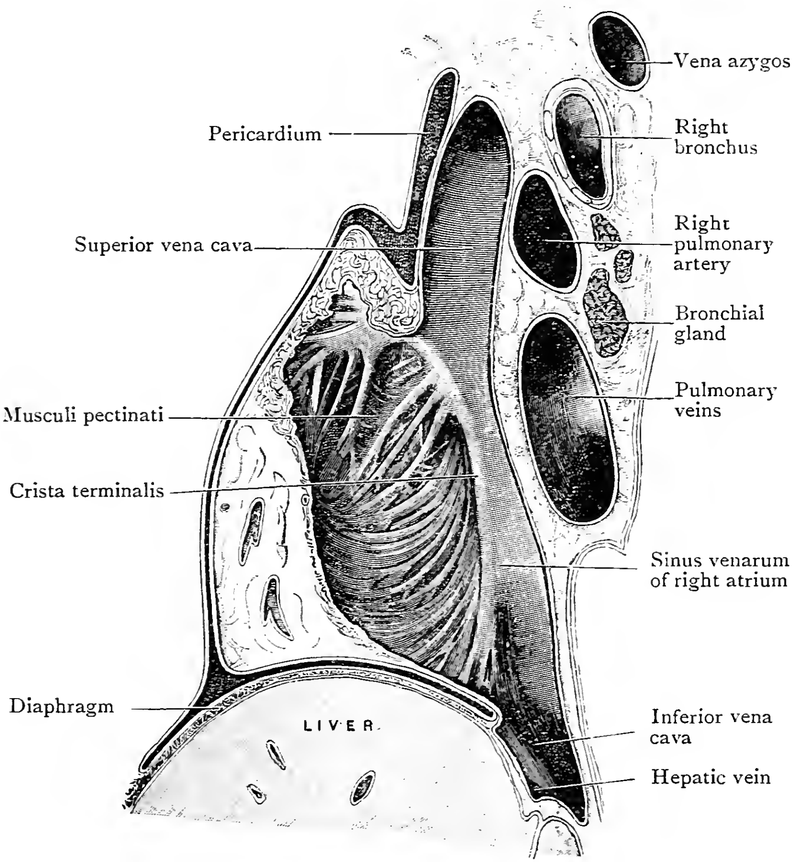

FIG. 43.—Sagittal section through the Right Atrium of the Heart and the Root of the Right Lung.

posterior part of the atrium, at the level of the third right costal cartilage.[1] It is entirely devoid of any valvular arrangement. Immediately below it, on the posterior wall of the atrium, in a well-fixed heart, will be found a rounded prominence,

[1] In the specimen shown in Fig. 46 it was at the level of the fourth costal cartilage.

the intervenous tubercle (Lower), which tends to throw the stream of blood entering the atrium by the superior vena cava downwards and forwards into the atrio-ventricular orifice.

The *orifice of the inferior vena cava* is in the lower and posterior part of the atrium, at the level of the sixth right costal cartilage[1] and the lower border of the eighth thoracic vertebra. Running along its anterior margin, and intervening between it and the atrio-ventricular opening, is the remnant of a valve, *the valve of the vena cava* (Eustachii). (Figs. 42, 44.) It terminates, to the left, in the lower end of a ridge, *limbus fossæ ovalis* (O.T. *annulus ovalis*), which lies on the inter-atrial septum and forms the anterior and upper boundary of a shallow fossa, the *fossa ovalis* (Figs. 42, 44). At the upper end of the fossa ovalis there was, during fœtal life, a foramen, the *foramen ovale*, through which the two atria communicated with each other. The object of the valve of the vena cava, which in fœtal life was much more perfect, was to direct the oxygenated inferior caval blood through the foramen ovale into the left atrium, whence

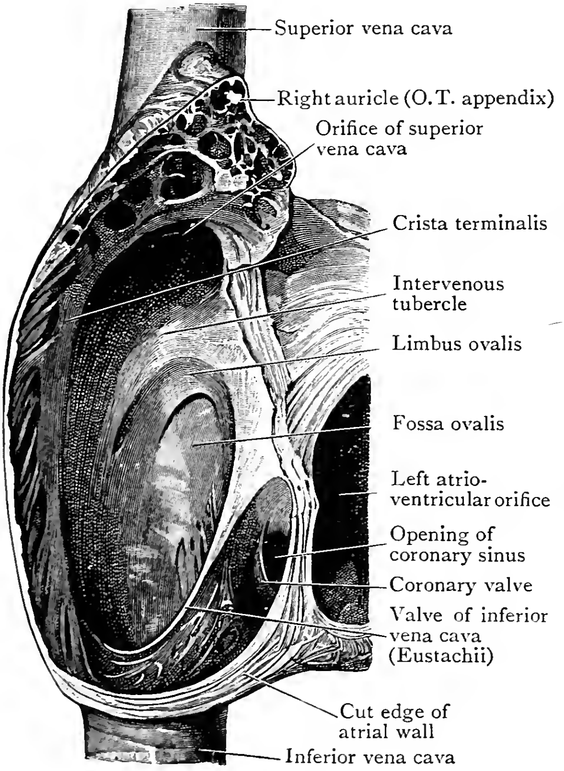

FIG. 44.—Interior of Right Atrium as seen by the removal of the anterior wall, or that wall opposed to the base of the Ventricles. This is a part of the same specimen that is depicted in Fig. 43.

[1] In the specimen shown in Fig. 46 it was at the level of the seventh costal cartilage.

it was passed into the left ventricle, and was then distributed, by the aorta, throughout the whole body.

During fœtal life it would have been useless for the blood to pass through the lungs, which were inactive and devoid of air. At the same time, had the oxygenated blood, which is poured into the upper part of the inferior vena cava by the vein from the placenta, passed through the right atrium into the right ventricle, it would have failed to reach the head and the upper extremities, for, leaving the right ventricle by the pulmonary artery, it would have entered the aorta through the ductus arteriosus beyond the origin of the left subclavian artery and, therefore, beyond the innominate and left common carotid arteries.

In many cases a small part of the foramen ovale persists in the adult. If it is present it will be found on the left of

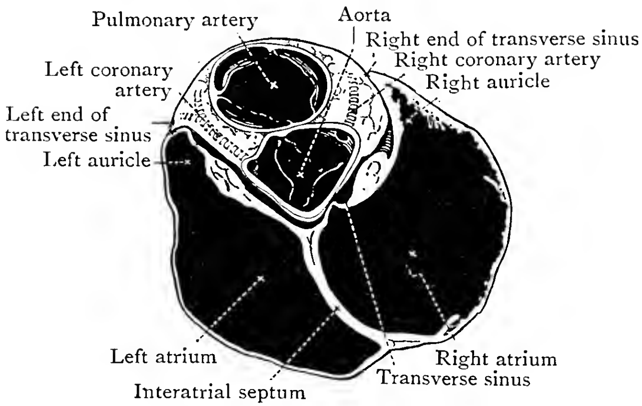

FIG. 45.—Transverse section through the Upper Part of the Heart.

the upper curved end of the limbus ovalis, and a probe should be passed through it into the left atrium.

The *opening of the coronary sinus* lies to the left of the lower end of the limbus ovalis and directly posterior to the tricuspid orifice, through which the right atrium communicates with the right ventricle (Figs. 42, 44). On its right margin lies a valvular fold, *the valve of the coronary sinus* (Thebesii), which turns the blood, flowing from left to right in the sinus, forwards into the atrio-ventricular orifice. The venæ cordis minimæ and the anterior cardiac veins open directly into the atrium by small orifices scattered irregularly over the walls.

The *tricuspid orifice* is in the lower and anterior part of the atrium. It opens forwards into the lower and posterior part of the cavity of the right ventricle, and is sufficiently large to admit the tips of three fingers. It is bounded by a fibrous

ring to which the cusps of the right atrio-ventricular valve are attached. These cusps will be examined when the right ventricle is opened.

The Septum Atriorum and the Fossa Ovalis.—The inter-

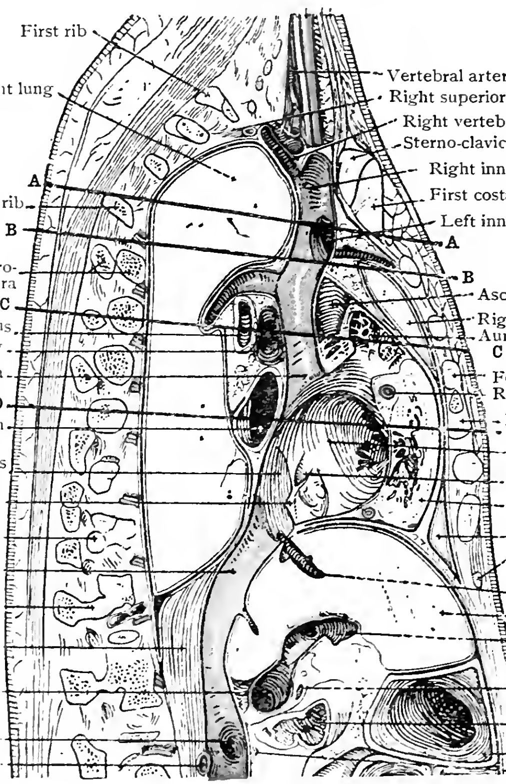

FIG. 46.—Sagittal section and partial dissection of the upper part of the trunk of a young Male Adult. The section is to the right of the median plane along the line of the superior and inferior venæ cavæ and it passes through the right margin of the left atrium of the heart. The atria were partially distended and the ventricles were contracted.

A-A Plane of section of Fig. 47.
B-B. ,, ,, ,,
C-C. ,, ,, ,,
D-D. ,, ,, ,,

atrial septum is a fibro-muscular partition which intervenes between the right and left atria (Fig. 45). In the fœtus it is pierced by an obliquely directed foramen, the foramen ovale, already referred to; and in the adult it is marked on the lower and posterior part of its right side by a shallow depres-

sion, *the fossa ovalis*, which is bounded anteriorly and above by a muscular ridge, *the limbus ovalis*, whilst below and posteriorly it fades away into the orifice of the inferior vena cava.

The floor of the fossa ovalis is thin; it marks the situa-

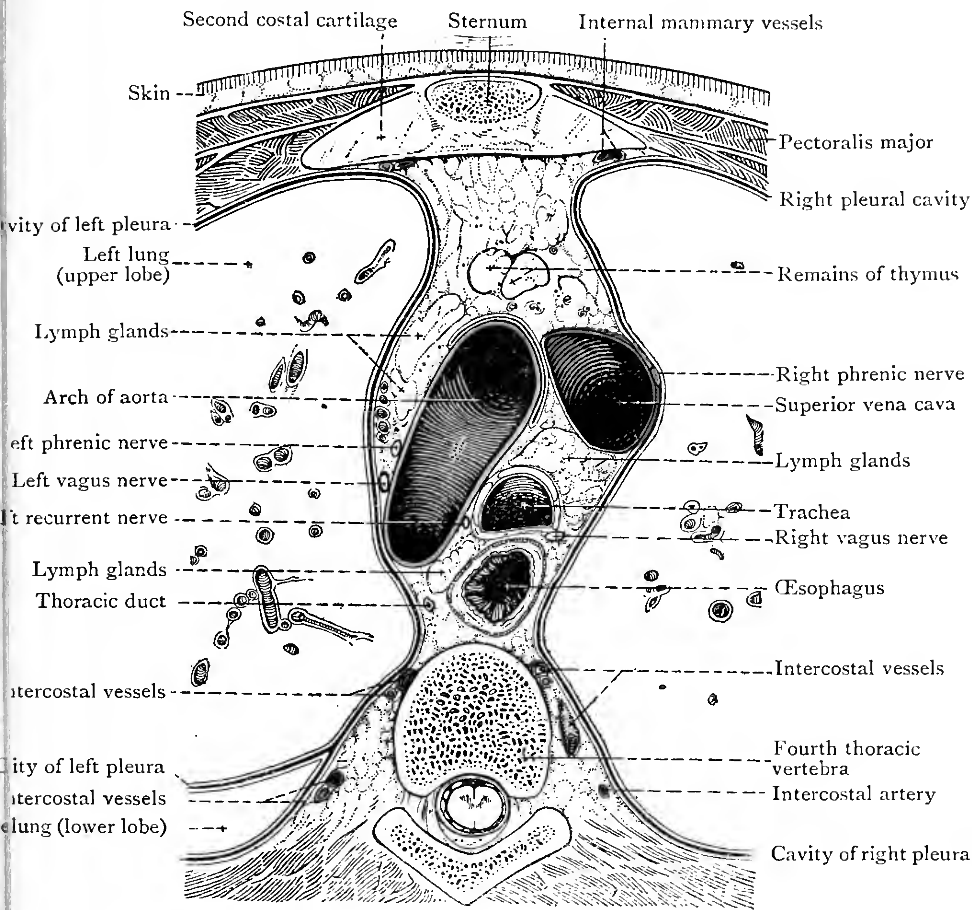

FIG. 47.—Transverse section of the Thorax of a Male Adult along the plane **B-B**, Fig. 46.

tion of the lower part of the boundary of the foramen ovale of the fœtus, and is formed by a portion of the interatrial wall which, in the fœtus, acted as a flap valve and prevented regurgitation of blood from the left to the right atrium.

Vena Cava Superior.—The superior vena cava returns to the right atrium the venous blood from the head and neck,

the upper extremities, the walls of the thorax, and the upper parts of the walls of the abdomen. It commences, by the union of the right and left innominate veins, at the level of the lower border of the sternal end of the first right costal cartilage (Figs. 27, 32); and it terminates, in the upper and posterior part of the right atrium, at the level of the third

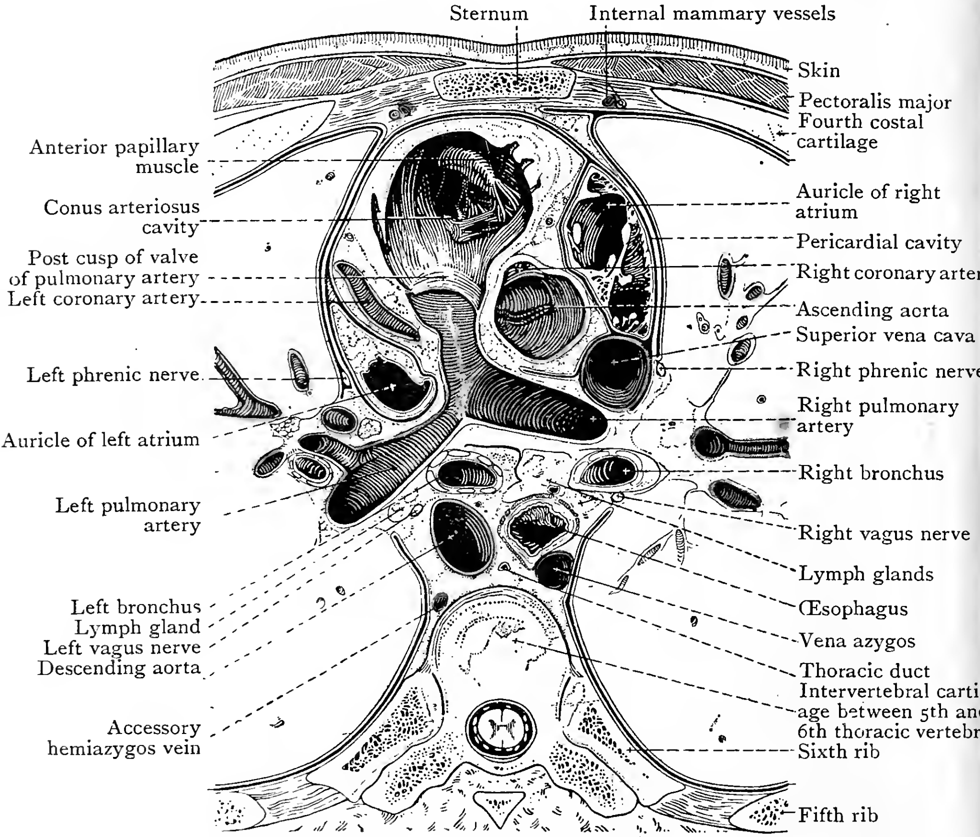

FIG. 48.—Transverse section through the Thorax of a young Male Adult along the plane **C-C**, Fig. 46.

right costal cartilage, at the right border of the sternum.[1] It lies partly in the superior and partly in the middle mediastinum, and its lower half is within the fibrous pericardium and is partly ensheathed by the serous pericardium (Fig. 32).

Tributaries.—The tributaries of the superior vena cava are the two innominate veins, by whose junction it is formed,

[1] In the specimen shown in Fig. 15 it terminated at the level of the fourth right costa cartilage.

and the vena azygos, which enters it immediately before it pierces the fibrous pericardium, at the level of the second right costal cartilage (Fig. 15).

Relations.—The superior vena cava lies to the right of, and somewhat posterior to, the ascending aorta. *Posterior to* its upper part are the right pleura and lung on the right, and the right vagus, trachea and the vena azygos on the left (Figs. 23, 57), and, at a lower level, the right bronchus, the right pulmonary artery (Fig. 20) and the upper right pulmonary vein pass behind it. *Anteriorly* and on the left it is overlapped by the ascending aorta, and on the right by the right pleura and lung. *On its left side*, above, is the lower end of the innominate artery, and below is the ascending aorta; and *on the right side* is the right pleura, with the phrenic nerve and the accompanying vessels intervening (Figs. 20, 56).

Vena Cava Inferior.—Only a small portion, about 18 mm. (three-quarters of an inch), of the inferior vena cava is found in the thorax. It ascends from the diaphragm along the mediastinal surface of the right pleura and lung, pierces the pericardium anterior to the lower border of the right ligamentum pulmonis, and immediately ends in the lower and posterior angle of the right atrium (Figs. 13, 15, 59).

Relations.—*Anterior to it* is the diaphragm; *posterior to it* the vena azygos, the greater splanchnic nerve and the thoracic duct; and *to its right* the phrenic nerve with its accompanying vessels and the right pleura and lung (see Fig. 11).

Dissection.—The cavity of the right ventricle should be opened by three incisions. The first should be made transversely across the upper end of the conus arteriosus, immediately below the commencement of the pulmonary artery. It should begin a little to the right of the upper end of the anterior longitudinal sulcus and terminate a little to the left of the coronary sulcus. The second must commence at the right end of the first and pass obliquely downwards and to the right, along the left margin of the coronary sulcus, to the inferior border of the heart. The third commences at the left end of the first, follows the line of the anterior interventricular sulcus, lying a little to its right side, and also terminates at the lower margin of the heart. After the triangular flap thus formed is turned downwards and to the right, the cavity of the ventricle should be cleaned with the aid of sponge and forceps. If the *moderator band* of muscle fibres, which connects the anterior wall of the ventricle with the interventricular septum, interferes with the necessary displacement of the flap it must be divided.

Ventriculus Dexter.—The cavity of the right ventricle has a triangular outline. The atrio-ventricular orifice opens into the lower and posterior angle, the pulmonary artery springs from the upper and posterior angle, and between the two orifices is a strong and rounded muscular ridge, *the supra-ventricular crest.* The supra-ventricular crest projects into the cavity of the ventricle, converting it into a U-shaped tube which commences posterior to and below the supra-ventricular crest,

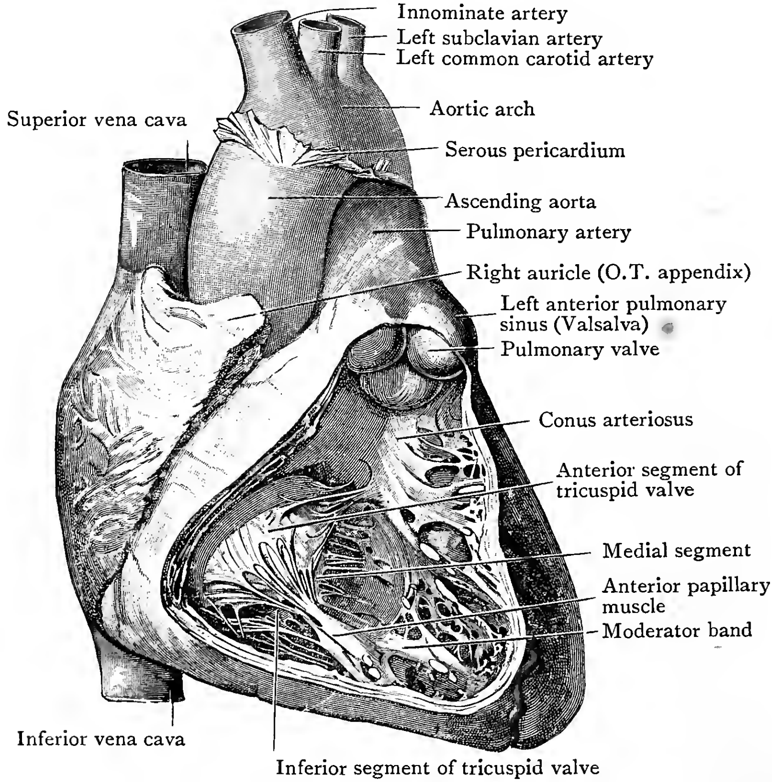

FIG. 49.—The Interior of the Right Ventricle.

runs forwards and to the left, towards the apex, and turns upwards and backwards, along the anterior part of the interventricular septum and anterior to the supra-ventricular crest, to the orifice of the pulmonary artery.

On transverse section the cavity of the right ventricle is semilunar in outline, in consequence of the thick interventricular septum, which forms the left and posterior wall, bulging into the cavity (Fig. 50). Its walls are much thicker than the walls of the right atrium, but much thinner than the

walls of the left ventricle (Fig. 50). The reason for the differences is obvious: the atrium has merely to force the blood through the wide atrio-ventricular orifice into the right ventricle, and the right ventricle has only to send the blood through the lungs to the left atrium; but the left ventricle has to force the blood through the whole of the trunk, the head and neck, and the limbs; and the muscular strength of the walls of the cavities of the heart is proportional to the work they have to do.

The portion of the right ventricle which ascends to the orifice of the pulmonary artery is the *conus arteriosus*. Its walls are smooth and devoid of projecting muscular bundles (Fig. 49); but the inner surface of the walls of the remaining part of the ventricle is rendered extremely irregular by the projection of a lace-work of fleshy ridges called *trabeculæ carneæ* (Figs. 49, 53). Some of the trabeculæ are merely ridges raised in relief upon the surface; others are attached to the wall at each extremity, but are free in the rest of their extent. The cavity of the ventricle is invaded, however, not only by the trabeculæ carneæ, but also by a number of conical muscular projections, the *musculi papillares*. The papillary muscles are attached by their bases to the wall of the ventricle, whilst their apices are connected, by a number of tendinous strands, called *chordæ tendineæ*, to the margins and the ventricular surfaces of the cusps of the atrio-ventricular valve. As a rule there is one large anterior papillary muscle attached to the anterior wall, a large inferior papillary muscle attached to the inferior wall, and a number of smaller papillary muscles attached to the septal wall. Occasionally the anterior and inferior muscles are repre-

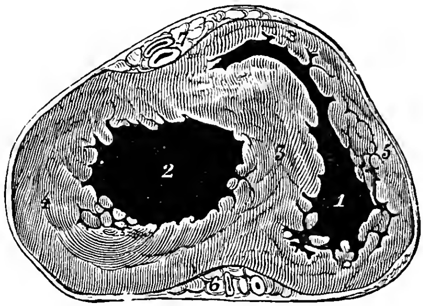

FIG. 50.—Transverse section through the Ventricular Part of the Heart seen from above. (From Luschka.)

1. Cavity of right ventricle.
2. Cavity of left ventricle.
3. Ventricular septum.
4. Thick wall of left ventricle.
5. Thinner wall of right ventricle.
6. Inferior longitudinal (interventricular) sulcus with middle cardiac vein and interventricular branch of right coronary artery.
7. Anterior longitudinal (interventricular) sulcus with great cardiac vein and interventricular branch of left coronary artery.

sented by a number of smaller projections. It must be noted that the chordæ tendineæ from each papillary muscle, or group of papillary muscles, gain insertion into the margins and ventricular surfaces of two adjacent cusps of the valve. The result of the arrangement is, as the papillary muscles contract simultaneously with the contraction of the general wall of the ventricle, that the chordæ tendineæ hold the margins of the cusps together and at the same time prevent them being driven backwards into the atrium.

One of the trabeculæ carneæ, which is usually strong and well marked, passes across the cavity from the septum to the base of the anterior papillary muscle. It is called the *moderator band.* It tends to prevent over-distension of the cavity of the ventricle, by fixing the more yielding anterior wall of the ventricle to the more solid septum.

There is one opening of entrance into the right ventricle, the atrio-ventricular, and one opening of exit, the pulmonary orifice. Each is guarded by a valve.

The *right atrio-ventricular orifice* lies at the lower and posterior part of the right ventricle, its centre being behind the middle of the sternum at the level of the fourth intercostal space. It is about one inch in diameter, and is surrounded by a fibrous ring. It admits the tips of three fingers, and it is guarded by a valve which possesses three cusps, and is called, therefore, the *tricuspid valve.*

Valvula Tricuspidalis.—The three cusps of the tricuspid valve occupy definite positions :—one is anterior, another medial, and the third inferior. The anterior cusp intervenes between the atrio-ventricular orifice and the conus arteriosus. The medial cusp lies in relation with the septal wall; and the inferior cusp with the inferior wall of the ventricle. Occasionally small additional cusps are interposed between the three main cusps.

The bases of the cusps are attached to the fibrous ring round the margin of the orifice. Their apices, margins and ventricular surfaces are attached to the chordæ tendineæ. Their atrial surfaces, over which blood flows as it enters the ventricle, are smooth, and their ventricular surfaces are more or less roughened by the attachment of the chordæ tendineæ, but the roughening is less marked on the ventricular surface of the anterior cusp over which the blood flows as it passes through the conus arteriosus to the pulmonary orifice.

The Atrio-ventricular Bundle.—The atrio-ventricular bundle is a small bundle of peculiar muscle fibres, of pale colour, which forms the only direct muscular connection between the walls of the atria and the ventricles (see p. 121). To expose it, the anterior part of the medial cusp of the tricuspid valve must be detached from the fibrous atrio-ventricular ring. When that has been done, the membranous upper part of the interventricular septum will be exposed, and the atrio-ventricular bundle will be found running along its posterior and lower border to the upper end of the muscular part of the interventricular septum, where it divides into right

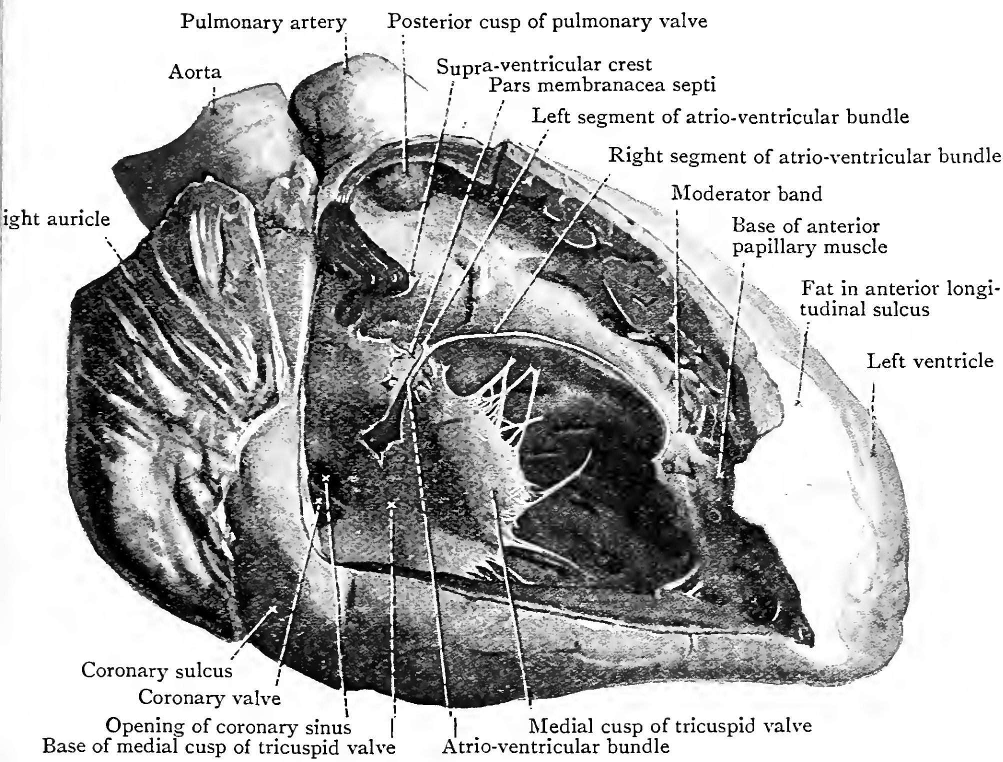

FIG. 51.—Dissection of the Right Ventricle showing the Atrio-ventricular Bundle.

and left branches. The right branch runs along the right side of the septum to the moderator band, along which it passes to the anterior papillary muscle. The left branch passes between the membranous part and the upper end of the muscular part of the septum, and then descends along the left side of the septum. Both branches send off numerous ramifications which are distributed to the various parts of the walls of the ventricles. It is only occasionally that the atrio-ventricular bundle can be displayed in the heart of an ordinary dissecting-room subject.

The *pulmonary orifice* lies at the upper, posterior, and left part of the ventricle, at the apex of the conus arteriosus. Its centre is behind the third left costal cartilage immediately to

the left of the left border of the sternum, and its margin is surrounded by a thin fibrous ring to which the bases of the three semilunar cusps of the pulmonary valve are attached.

Dissection.—Note that immediately above its commencement the wall of the pulmonary artery shows three distinct bulgings; they are the pulmonary sinuses (Valsalva), of which two are anterior, and the third is situated posteriorly. Make a transverse incision across the wall of the pulmonary artery immediately above the dilatations, and from each end of the transverse incision make a vertical incision upwards towards the arch of the aorta; raise the flap so formed and examine the cusps of the valve from above.

The Pulmonary Valve.—Each cusp of the valve is of semilunar form. Its upper or arterial surface is concave, its lower or ventricular surface is convex; and it consists of a layer of fibrous tissue covered, on each surface, with a layer of endothelium. The fibrous basis of the cusp is not equally thick in all parts. A stronger band runs round both the free and the attached margin. The centre of the free margin is thickened to form a small rounded mass—the *nodulus of the valve*—and the small thin semilunar regions on each side of the nodule are called the *lunulæ of the valve.* When the ventricular contraction ceases, and the elastic reaction of the wall of the pulmonary artery forces the blood backwards towards the ventricle, the cusps of the valve are forced into apposition; the nodules meet in the centre of the lumen; the ventricular surfaces of the lunulæ of adjacent cusps are compressed against each other, and their free margins project upwards into the cavity of the artery, in the form of three vertical ridges which radiate from the nodules to the wall of the artery. Regurgitation of blood into the ventricle is thus prevented.

The dissector may readily demonstrate the general appearance of the cusps and their relationship to each other by packing the concavity of each cusp with cotton wool.

Arteria Pulmonalis.—The stem of the pulmonary artery is about 50 mm. (two inches) long. It lies within the fibrous pericardium, enclosed, with the ascending part of the aorta, in a common sheath of the serous pericardium. It commences at the upper end of the conus arteriosus, posterior to the sternal extremity of the third left costal cartilage; and it runs, backwards and upwards, into the concavity of the aortic arch, where it bifurcates into two branches,

the right and left pulmonary arteries. The bifurcation takes place posterior to the sternal end of the second left costal cartilage.

Relations.—At its commencement it is placed anterior to the lower end of the ascending aorta, but as it runs backwards and upwards it passes to the left side of the aorta, and lies in front of the upper part of the anterior wall of the left atrium, from which it is separated by the transverse sinus of the pericardium. Anterior to it is the upper part of the anterior wall of the pericardium, which separates it from the anterior part of the mediastinal surface of the left pleura and lung. To its right side are the right coronary artery and the apex of the auricle of the right atrium, below, and the ascending aorta, above. To its left side lie the left coronary artery and the anterior end of the auricle of the left atrium.

Dissection.—Cut away the anterior wall of the pulmonary artery up to the level of its bifurcation and pass probes into its right and left branches. Note that the right branch runs nearly transversely to the right, and that the left branch runs backwards and to the left.

The *right pulmonary artery* commences at the bifurcation of the pulmonary stem, below the arch of the aorta. It at once runs to the right, towards the hilum of the right lung, along the upper border of the left atrium and the transverse sinus of the pericardium (Figs. 28, 37, 59). It passes behind the ascending aorta and the superior vena cava, and in front of the œsophagus and the stem of the right bronchus. It enters the hilum of the lung below the eparterial branch of the bronchus, above and posterior to the upper right pulmonary vein; and it descends, in the substance of the lung, on the postero-lateral side of the stem bronchus, and between its ventral and its dorsal branches, where it has already been dissected (p. 59).

Branches.—As it enters the hilum of the lung it gives off a branch which accompanies the eparterial bronchus, and as it descends in the substance of the lung it gives off branches which correspond with the branches of the stem bronchus (see p. 62).

The *left pulmonary artery* runs to the left and slightly backwards, across the anterior aspect of the descending aorta and the left bronchus, to the hilum of the left lung (Figs. 20, 25). It is covered anteriorly and on the left by the

anterior part of the mediastinal surface of the left pleural sac. As it descends in the substance of the lung it lies along the postero-lateral aspect of the stem bronchus and between its ventral and dorsal branches (p. 62).

Branches.—The branches of the left pulmonary artery are similar to those given off by the right pulmonary artery, except that it has no branch corresponding with that which accompanies the eparterial bronchus on the right side.

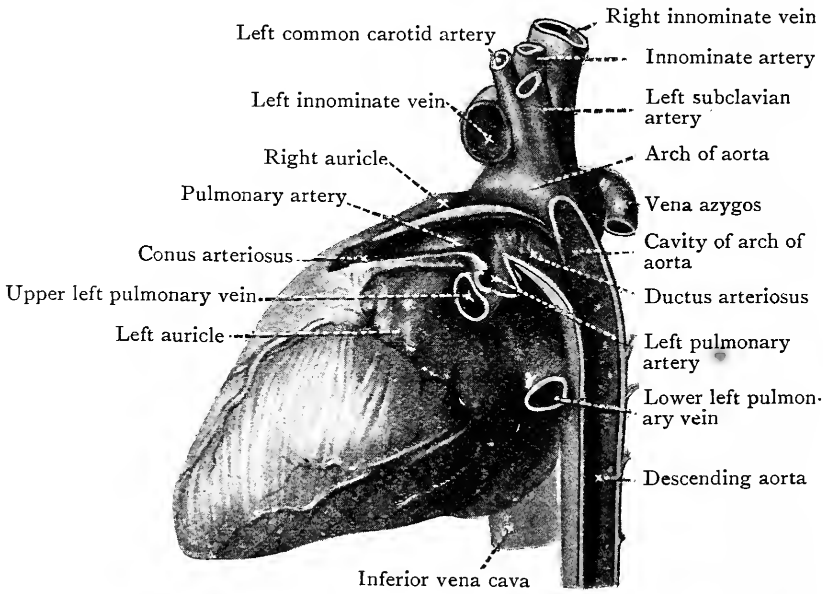

FIG. 52.—Dissection of the Heart and Great Vessels of a Fœtus, showing the angular junction of the Ductus Arteriosus with the Aorta.

Ligamentum Arteriosum.—The ligamentum arteriosum has already been displayed. It is a fairly strong fibrous band which connects the commencement of the left pulmonary artery with the lower surface of the arch of the aorta. In the adult it has no particular importance, and its interest lies in the fact that it is the remains of the walls of a wide channel, the *ductus arteriosus* (Fig. 52), which united the left pulmonary artery with the aorta throughout pre-natal life.

During fœtal life the lungs had no aerating function ; therefore the right pulmonary artery and the part of the left pulmonary artery beyond the origin of the ductus arteriosus were small, for they had merely to convey sufficient blood to maintain the life and growth of the non-functional lungs. At that period, therefore, the blood which had entered the right ventricle, through the superior vena cava and the right atrium (see p. 92), was ejected,

by the ventricle, into the pulmonary artery, and the greater part of it passed through the ductus arteriosus into the aorta, which it entered beyond the origin of the left subclavian artery, and there mingled with the more oxygenated blood from the placenta, the lower part of the trunk, and the lower limbs, which passed from the inferior vena cava, through the right atrium and the foramen ovale, to the left atrium, and thence to the left ventricle, by which it was pumped into the aorta.

It is obvious that the passage of blood from the pulmonary artery into the aorta could take place only so long as the pressure in the pulmonary artery was greater than the pressure in the aorta. At birth, when the blood rushes through the rapidly enlarged right and left pulmonary arteries into the lungs, as they expand with the first respiratory efforts, the pressure in the pulmonary artery and the ductus arteriosus is reduced below that in the aorta, and blood would flow, from the aorta, through the ductus arteriosus into the pulmonary artery were it not that an alteration of the position of the heart, caused by the expansion of the lungs, produces a twisting of the arterial duct which results in the obliteration of its channel. After blood ceases to flow through it the duct rapidly contracts, and is ultimately reduced to the condition of a fibrous ligament. In a few cases the duct remains open and then peculiar physical signs are produced with which the student will become acquainted during the course of his medical work.

Note that the left recurrent nerve curves round the lower surface of the aortic arch on the left side of the upper end of the ligamentum arteriosum, and that the superficial cardiac plexus lies below the aortic arch immediately to the right of the ligament.

Dissection.—Cut through the remains of the upper part of the conus arteriosus immediately below the bases of the cusps of the pulmonary valve, and carefully dissect the upper part of the conus and the lower part of the pulmonary artery away from the front of the commencement of the ascending aorta. When that has been done, turn the lower end of the pulmonary artery upwards and pin it to the arch of the aorta (see Fig. 53). The upper part of the anterior wall of the left ventricle and the commencement of the aorta are now exposed, and the dissector should note three bulgings at the commencement of the aorta—the three aortic sinuses. One of the three sinuses lies anteriorly, and the right coronary artery springs from it (Fig. 45). The other two, a right and a left, lie posteriorly, and the left coronary artery springs from the left sinus.

Make a transverse incision across the upper end of the left ventricle, a short distance below the base of the anterior aortic sinus. On the right side extend the incision into the upper part of the interventricular septum and carry it downwards, cutting through the anterior part of the septum as far as the apex of the heart. From the left extremity of the upper transverse incision carry an incision downwards and forwards through the left lateral border of the anterior surface of the left ventricle, parallel with the incision already made in the septum, towards the apex. As this incision is made, pull the anterior wall of the left ventricle forwards till the base of a large papillary muscle which springs from

its internal surface is exposed; carry the incision anterior to that muscle and then onwards to the apex, and remove the anterior wall of the left ventricle and the anterior part of the interventricular septum. The cavity of the left ventricle and the mitral valve, which guards the left atrio-ventricular orifice, are now exposed (Fig. 53).

Ventriculus Sinister.—The cavity of the left ventricle is longer and narrower than that of the right ventricle. It reaches to the apex, and when exposed from the front it appears to be of conical shape. In cross section it has a circular or broadly oval outline, and its walls are very much thicker than those of the right ventricle (Fig. 50). When the interior has been cleaned with the aid of a sponge and forceps, the dissector will note that its walls are covered with a dense mesh-work of *trabeculæ carneæ*, which are finer and much more numerous than those met with in the right ventricle. The network is especially complicated at the apex and on the inferior wall of the ventricle, whilst the surface of the septum and the upper part of the anterior wall are, comparatively speaking, smooth. But whilst the trabeculæ carneæ in the left ventricle are slighter and more numerous than those in the right, the *musculi papillares*, on the other hand, are less numerous and much stronger; indeed, as a general rule there are only two papillary muscles in the left ventricle, an anterior and an inferior, the former attached to the anterior wall and the latter to the inferior wall of the cavity. The *chordæ tendineæ* from the papillary muscles pass to the margins and to the ventricular surfaces of the two cusps of the mitral valve, which guards the left atrio-ventricular orifice, the chordæ tendineæ from each papillary muscle gaining attachment to the adjacent margins of both cusps.

Dissection.—Detach the anterior papillary muscle from the anterior wall of the ventricle and note that its chordæ tendineæ go to the anterior and left margins of the cusps of the mitral valve. Introduce the blade of a scalpel between the anterior margins of the cusps and carry it downwards between the groups of chordæ going to the apex of the papillary muscle; then split the papillary muscle from its apex to its base, leaving each half connected with a corresponding group of chordæ tendineæ. The cusps of the mitral valve can now be separated from each other, and the atrio-ventricular orifice and the cavity of the ventricle can be more completely examined.

The Orifices of the Left Ventricle.—There are two orifices of the left ventricle—one of entrance, the left atrio-ventricular orifice, and one of exit, the aortic orifice.

The Left Atrio-ventricular Orifice.—The left atrio-ventricular orifice lies in the lower and posterior part of the ventricle, posterior to the left margin of the sternum, at the level of the fourth left costal cartilage. It is somewhat smaller than the right atrio-ventricular orifice and admits the tips of two fingers only, a fact which will be better appreciated when the orifice is examined from the left atrium, at a later period. It is guarded by a valve, formed by two cusps and called, therefore, the *bicuspid valve*, which prevents regurgitation of blood from the left ventricle into the left atrium.

Valvula Bicuspidalis.—The bicuspid, mitral or left atrio-ventricular valve consists of two cusps, a large superior (anterior) and a small inferior (posterior). Occasionally, however, as on the right side, small additional cusps are interposed between the bases of the main cusps. The bases of the cusps are attached to a fibrous ring which surrounds the atrio-ventricular orifice, and their apices project into the cavity of the ventricle. To their apices, margins and ventricular surfaces are attached the chordæ tendineæ from the papillary muscles, which hold the margins of the cusps together and prevent the valve being driven backwards into the atrium during the contraction of the ventricle. The dissector should note, however, that the chordæ tendineæ spread less over the ventricular surface of the superior cusp than over that of the inferior cusp, and he should associate this fact with the circumstance that blood flows over both surfaces of the large superior cusp, which intervenes between the atrio-ventricular and the aortic orifices. By means of the large superior cusp of the mitral valve the cavity of the ventricle, which has, on the whole, a somewhat conical form, is converted into a bent U-shaped tube, one limb of the tube lying below and to the left, and the other anteriorly and to the right. The blood enters the ventricle below and posteriorly through the atrio-ventricular orifice. It runs forwards towards the apex of the cavity along the inferior surface of the superior cusp of the mitral valve, then, as the ventricle contracts, it is driven upwards, backwards, and to the right, to the aortic orifice, along the anterior surface of the large anterior cusp of the mitral valve. The portion of the cavity of the left ventricle which lies directly below the aortic orifice is known as the *aortic vestibule* (Fig. 53). Its walls consist mainly of fibrous tissue;

therefore they remain quiescent during the contraction of the ventricle and, as a result, the rapid closure of the aortic valve is not interfered with when the ventricular contraction ceases and the elastic reaction of the walls of the aorta tends to force blood back into the ventricle.

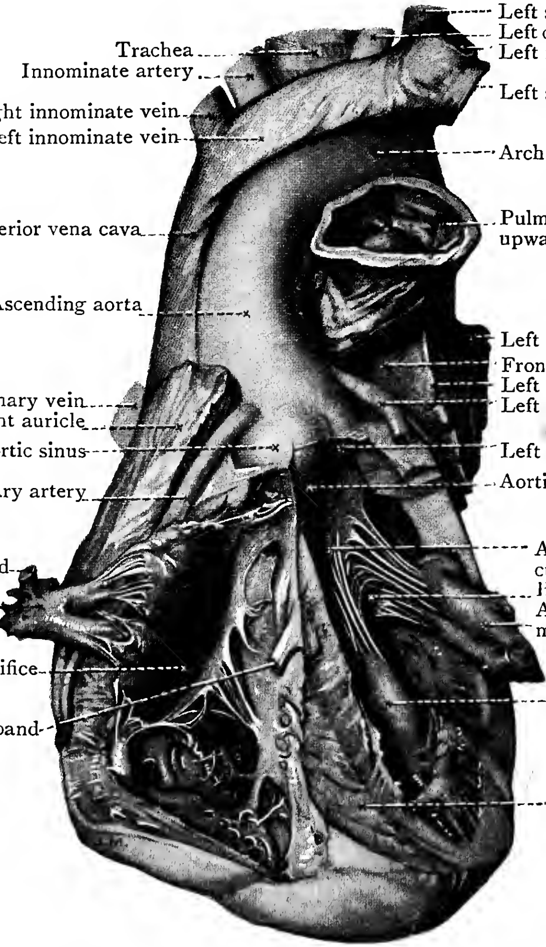

FIG. 53.—Dissection of the Heart from the anterior aspect.

The *aortic orifice* lies at the upper, right, and posterior part of the cavity, posterior to the left margin of the sternum, at the level of the third intercostal space. Its left and inferior margin is separated from the atrio-ventricular orifice by the superior cusp of the mitral valve. It is guarded by a valve, *the aortic valve*, which prevents regurgitation from the aorta into the ventricle. The aortic valve, like the pulmonary

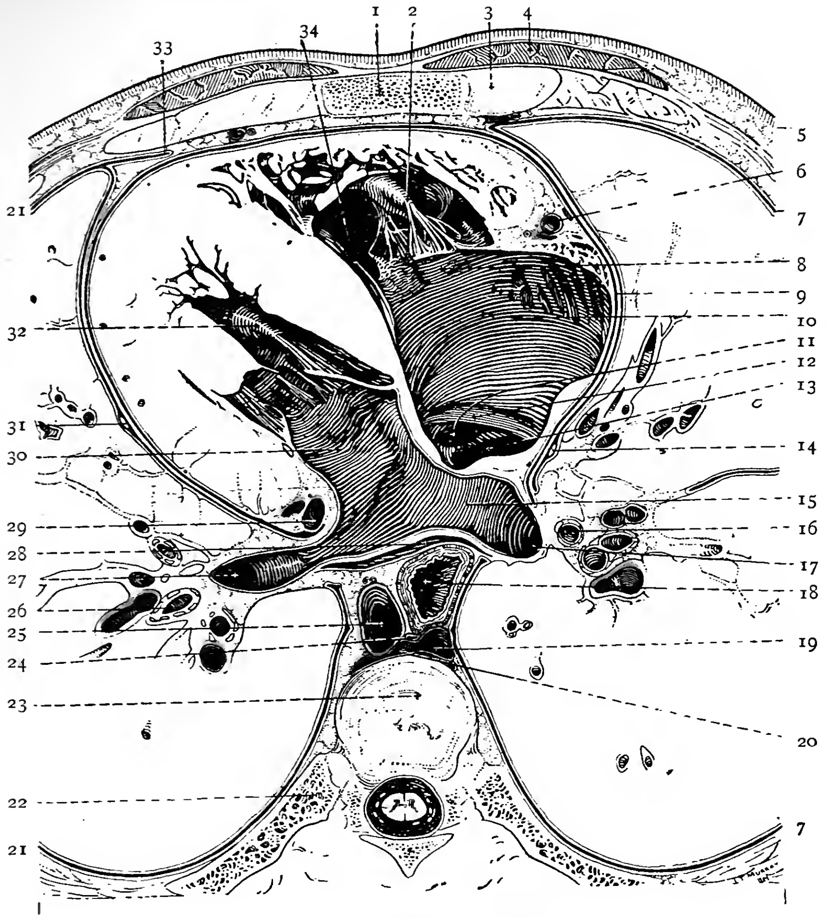

FIG. 54.—Transverse section through the Thorax of a young Male Adult along the plane **D-D**, Fig. 15.

1. Sternum.
2. Papillary muscle of right ventricle.
3. Fifth costal cartilage.
4. Pectoralis major.
5. Skin.
6. Right coronary artery.
7. Cavity of right pleura.
8. Musculi pectinati.
9. Pericardium.
10. Cavity of right atrium.
11. Opening of hepatic vein.
12. Valve of inferior vena cava.
13. Inferior vena cava.
14. Right phrenic nerve.
15. Left atrium.
16. Right bronchus.
17. Lower right pulmonary vein.
18. Œsophagus.
19. Vena azygos.
20. Accessory hemiazygos vein.
21. Cavity of left pleura.
22. Eighth rib.
23. Intervertebral cartilage between seventh and eighth thoracic vertebræ.
24. Thoracic duct.
25. Descending aorta.
26. Left bronchus.
27. Lower left pulmonary vein.
28. Oblique sinus of pericardium.
29. Coronary sinus.
30. Left atrio-ventricular orifice.
31. Left phrenic nerve.
32. Inferior papillary muscle of left ventricle.
33. Anterior margin of left pleura.
34. Septal cusp of tricuspid valve.

valve, consists of three semilunar cusps, but, in contra-

distinction to the pulmonary valve, one of the cusps is placed anteriorly and the other two posteriorly. The cusps of the aortic valve are stronger than the cusps of the pulmonary valve described on p. 102, but correspond with them in all details of structure.

Before terminating his examination of the left ventricle the dissector should note that the muscular wall of the cavity is thickest a short distance from the atrio-ventricular orifice and thinnest at the apex; and he should examine the interventricular septum.

Septum Ventriculorum.—The interventricular septum is a musculo-membranous partition which separates the left ventricle not only from the right ventricle, but also from the lower part of the right atrium. In the greater part of its extent the septum is thick and muscular—*septum musculare ventriculorum*—but its upper and posterior part which is connected with the fibrous rings round the atrio-ventricular orifices, and the orifices of the pulmonary artery and the aorta, is membranous—*septum membranaceum ventriculorum* (Fig. 55). The muscular part of the septum is thickest below and anteriorly, where it springs from the lower border of the heart immediately to the right of the apex and opposite the cardiac notch, but it becomes gradually thinner as it passes upwards and backwards to its union with the membranous part. The membranous portion is the thinnest part of the septum. Occasionally it is deficient in whole or in part, and in such cases a communication exists between the two ventricles, and, in some rare cases, between the left ventricle and the right atrium.

The membranous part of the septum was exposed, from the right side, when the anterior part of the medial cusp of the tricuspid valve was removed if the dissection of the atrio-ventricular bundle was attempted (see p. 101).

Finally, the dissector should note that the interventricular septum is placed obliquely, so that its anterior border lies to the left and its inferior border to the right; and that its right lateral surface, which looks forwards and to the right, bulges towards the cavity of the right ventricle (Fig. 50).

The Aorta.—The aorta is the great arterial trunk of the body. It commences from the upper, posterior and right portion of the left ventricle, at the level of the third inter-

costal spaces and posterior to the left margin of the sternum. It terminates at the level of the lower part of the fourth lumbar vertebra, to the left of the median plane, where it divides into the right and left common iliac arteries. It is described as consisting of three main parts: (1) the ascend-

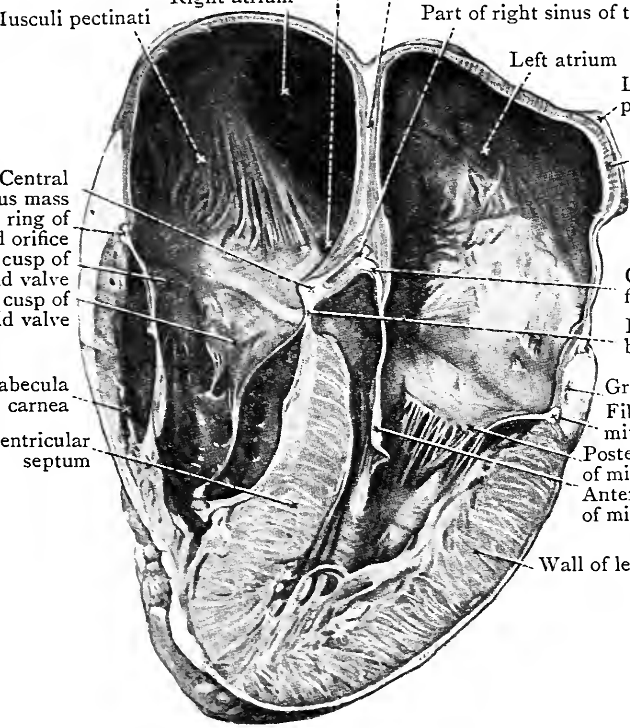

FIG. 55.—Section of the Heart showing the Interventricular and Inter a tria Septa and the Fibrous Rings round the Orifices.

ing part, (2) the arch, and (3) the descending part. The descending part is divided into (*a*) thoracic and (*b*) abdominal portions. The first two parts and the thoracic portion of the third part are met with in the dissection of the thorax.

The Ascending Part of the Aorta.—The ascending aorta (Figs. 20, 28, 53, 56) commences at the aortic orifice of the left ventricle and runs upwards, to the right and slightly forwards, posterior to the first piece of the body of the sternum, to the level of the sternal end of the second right costal cartilage, where it becomes the arch of the aorta. It lies in the middle mediastinum, is enclosed in

the fibrous sac of the pericardium, and is ensheathed by a covering of the serous sac which is common to it and the stem of the pulmonary artery. The lumen of the ascending portion of the aorta is not of uniform diameter; on the contrary, it presents four dilatations, three at the commence-

FIG. 56.—Transverse section through the Mediastinum at the level of the fifth thoracic vertebra.

ment, the *aortic sinuses* (Valsalvæ), and one along the right border, the *great sinus of the aorta*. The latter is merely an ill-defined bulging along the right border of the vessel.

Relations.—The lower part of the ascending aorta lies posterior to the upper part of the conus arteriosus and the lower part of the stem of the pulmonary artery; but the upper part is in direct relation with the anterior wall of the pericardium, which separates it from the anterior part of the mediastinal

surface of the right pleura and lung. Posterior to the ascending aorta, from below upwards, are both atria, the right pulmonary artery and the right bronchus. To the right are the auricle of the right atrium, below, and the superior vena cava, above; and to the left lie the left auricle, below, and the upper part of the stem of the pulmonary artery, above.

Branches.—Only two branches are given off from the ascending part of the aorta; they are the right and left coronary arteries. The right springs from the anterior aortic sinus and the left from the left posterior sinus. Their distribution has been described already (p. 84).

The Arch of the Aorta.—The aortic arch commences at the termination of the ascending part of the aorta, at the level of the second costal cartilage, and posterior to the right margin of the sternum, from which it is separated by the anterior part of the mediastinal portion of the right pleura and lung, or by the remains of the thymus (Figs. 46, 57). It runs backwards, to the left, and slightly upwards, through the middle mediastinum and round the left margins of the trachea and œsophagus (see Figs. 23 and 57), to the level of the lower border of the left side of the fourth thoracic vertebra, where it becomes continuous with the descending part of the aorta. It is curved in both the vertical and the horizontal planes, and as it passes backwards and to the left it forms a convexity upwards, and also a convexity which is directed forwards and to the left. Its lower border is connected with the left pulmonary artery by the ligamentum arteriosum, and from its upper border arise the three great vessels which supply the head, neck and superior extremities (Figs. 32, 39).

Relations.—*Above*, the left innominate vein runs along its upper border, immediately anterior to the inferior parts of the innominate artery, the left common carotid artery and the left subclavian artery, which spring from it; the innominate artery arises from the apex of the convexity of the arch, posterior and a little to the left of the centre of the manubrium sterni; the left common carotid artery arises close to, and sometimes in common with, the innominate artery, whilst the origin of the left subclavian artery is a little more posterior and to the left, separated by a distinct interval from the left common carotid (Fig. 32).

Below the arch lie—(1) the bifurcation of the stem of the pulmonary artery and portions of its right and left

branches; (2) the ligamentum arteriosum, which connects the commencement of the left pulmonary artery with the arch; (3) the superficial part of the cardiac plexus, immediately to the right of the ligamentum arteriosum; (4) the left recurrent

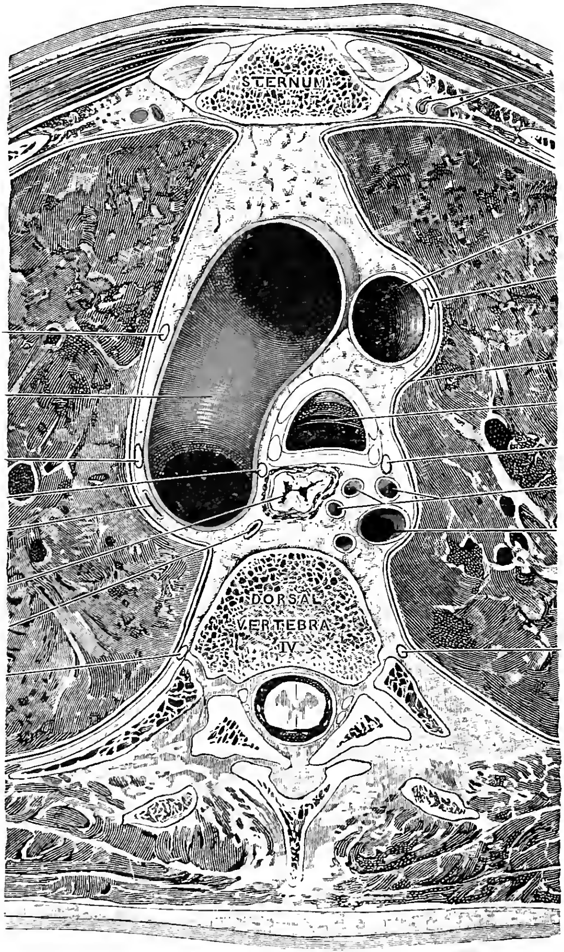

FIG. 57.—Transverse section through the Superior Mediastinum at the level of the fourth thoracic vertebra.

nerve, on the left side of the ligament; and (5) still further to the left, the left bronchus passes beneath the arch on its way to the hilum of the left lung. *To the right* of the arch and somewhat behind it are the trachea, the œsophagus, the left recurrent nerve, and the thoracic duct. The nerve lies in the angle between the œsophagus and the trachea, and the thoracic duct is posterior to, and to the left of, the

œsophagus (Fig. 57). The left side of the arch, which is curved so that it is directed forwards as well as to the left, is related to the mediastinal surface of the left pleura and lung, but intervening between the pleura and the arch are—(1) the remains of the thymus gland, (2) the left phrenic nerve, (3) the inferior cervical cardiac branch of the left vagus, (4) the superior cervical cardiac branch of the left sympathetic, (5) the left vagus, and (6) the left superior intercostal vein. The vein passes upwards and forwards, lying to the left of the vagus and the cardiac nerves, and to the right of the phrenic nerve (Figs. 47, 57).

Dissection.—Divide the right coronary artery close to its origin. Cut through the anterior wall of the ascending part of the aorta on each side of the anterior aortic sinus; extend the incisions upwards to the commencement of the aortic arch, and examine the aortic valve. Note that it is formed by three semilunar cusps which are much stronger than the semilunar cusps of the pulmonary valve (p. 102), but are exactly similar in structure and attachments. Note further that one cusp lies anteriorly, and the other two posteriorly. Examine the aortic sinuses and note that the right coronary artery springs from the anterior sinus, and the left coronary from the left posterior sinus. Note further that the orifices of the coronary arteries, as a rule, lie immediately above the level of the upper margins of the semilunar cusps. Replace the stem of the pulmonary artery in position, and note the relative positions of the pulmonary, aortic, and atrio-ventricular orifices.

Topography of the Great Orifices of the Heart.—Replace the sternum in position and note the relations of the cardiac orifices to the bone. The pulmonary orifice is highest. It lies to the left of the margin of the sternum at the level of the third costal cartilage. The aortic orifice is a little lower, and more to the right, posterior to the left margin of the sternum, at the level of the third left intercostal space. Below the aortic orifice is the left atrio-ventricular orifice, posterior to the left margin of the sternum at the level of the left fourth costal cartilage. Still lower and more to the right is the right atrio-ventricular orifice, posterior to the centre of the sternum at the level of the fourth intercostal spaces (Fig. 58).

Dissection.—Divide the phrenic nerves immediately above the diaphragm; then, with the handle and the edge of the scalpel, detach the lower part of the pericardium from the diaphragm. The attachment of the pericardium to the muscular part of the diaphragm is not close, and can easily be broken down. The attachment to the central tendon is much more firm and, as the median plane is approached, the aid of the edge

of the knife will probably be necessary before a separation can be effected. Divide the right innominate vein and the right phrenic nerve, immediately above the upper end of the superior vena cava, and as the division is made take care not to injure the right vagus, posterior to the vein. Then divide the vena azygos just posterior to its entrance into the superior vena cava. Cut the inferior thyreoid veins, the innominate artery and the left common carotid artery, immediately above the upper border of the left innominate vein, and then if the left innominate vein has not already been divided, divide it in the interval between the left common carotid and the left subclavian arteries. Cut the left phrenic nerve, the superior cervical cardiac branch of the left sympathetic trunk, and the inferior cervical cardiac branch of the left vagus, immediately above the upper border of the aortic arch.

Next divide the aortic arch. Enter the knife at the upper border of the arch, between the left common carotid and left subclavian arteries and anterior to the left vagus and the left recurrent nerve, and cut from above downwards, completing the division of the arch at the lower border, immediately to the left of the upper end of the ligamentum arteriosum. The left superior intercostal vein will be divided at the same time, but care must be taken not to injure the left recurrent nerve, which is curving round the arch from the front to the back. When the incisions are completed, pull forwards the anterior part of the aortic arch, with the superior vena cava and the lower parts of the innominate veins, and separate them from the lower part of the trachea and from the bronchi. As the separation proceeds, keep the edge of the knife turned towards the aortic arch, to avoid injury to the deep part of the cardiac plexus, which lies anterior to the bifurcation of the trachea. When the lower border of the arch is reached, the twigs which connect the superficial with the right half of the deep part of the cardiac plexus will be exposed, and must be divided. When that has been done, detach the posterior surface of the pericardium from the front of the œsophagus and the descending aorta, taking care to avoid injury to the plexus formed by the vagi nerves on the anterior aspect of the œsophagus. As soon as the separation is completed, the heart, with the remains of the pericardium and the lower parts of the phrenic nerves, can be removed from the thorax, and the investigation of the left atrium and the structure of the heart can be proceeded with ; but, before that is done, the dissector should note that the posterior wall of the pericardium intervenes between the posterior wall of the left atrium and the anterior surfaces of the œsophagus and the descending part of the aorta, opposite the middle four thoracic vertebræ (Fig. 28).

After the heart and the roots of the great vessels have been removed from the thorax, fasten the left vagus and the recurrent nerve to the part of the arch left *in situ* by one or two points of suture ; then cut away the remains of the pericardium from the heart, leaving only those portions of it which mark the lines of reflection of the parietal to the visceral portions of the serous sac. Note, as the posterior wall of the pericardium is removed, that it forms the posterior boundary of the oblique sinus (p. 81).

Atrium Sinistrum.—The left atrium, like the right, is

separable into two parts—a larger main portion, the atrium proper or body; and a long narrow prolongation, the auricle (O.T. auricular appendage), which runs from the left margin of the body forwards and to the right. The four pulmonary

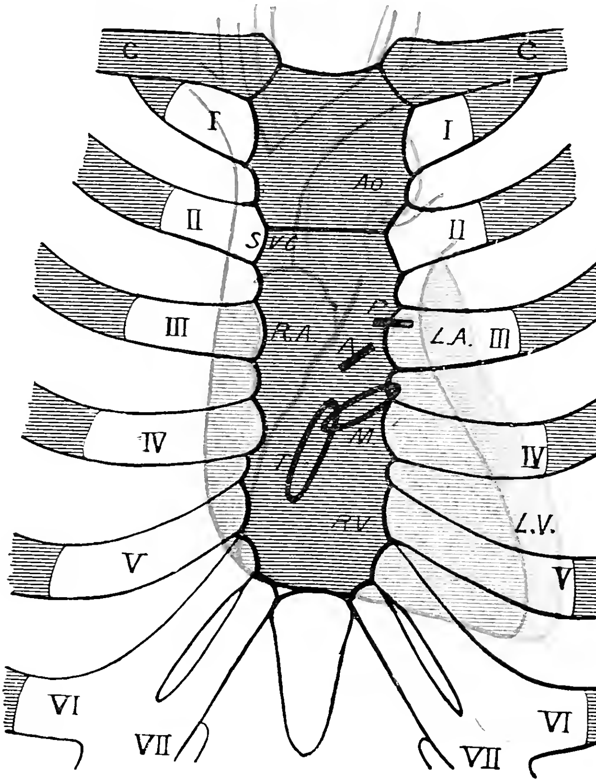

FIG. 58.—The relations of the Heart and of its Orifices to the Anterior Thoracic Wall.

I to VII. Costal cartilages.
A. Aortic orifice.
Ao. Arch of Aorta.
C. Clavicle.
LA. Left atrium.
LV. Left ventricle.
M. Mitral orifice.
P. Pulmonary orifice.
RA. Right atrium.
RV. Right ventricle.
SVC. Superior vena cava.
T. Tricuspid orifice.

veins, two on each side, open into the left atrium. They enter close to the upper ends of the lateral borders of the posterior surface, and not uncommonly the right or the left pair may fuse into a common trunk at the point of entrance.

It has been noted previously that the left atrium forms the greater part of the base of the heart, a small part of the anterior or sterno-costal surface, and a still smaller part of

the left border. The only part which can be seen from the front, when the heart and great arteries are *in situ*, is the apical portion of the auricle (appendage), for the portion which enters into the formation of the sterno-costal surface is hidden by the roots of the aorta and the pulmonary artery (Fig. 39).

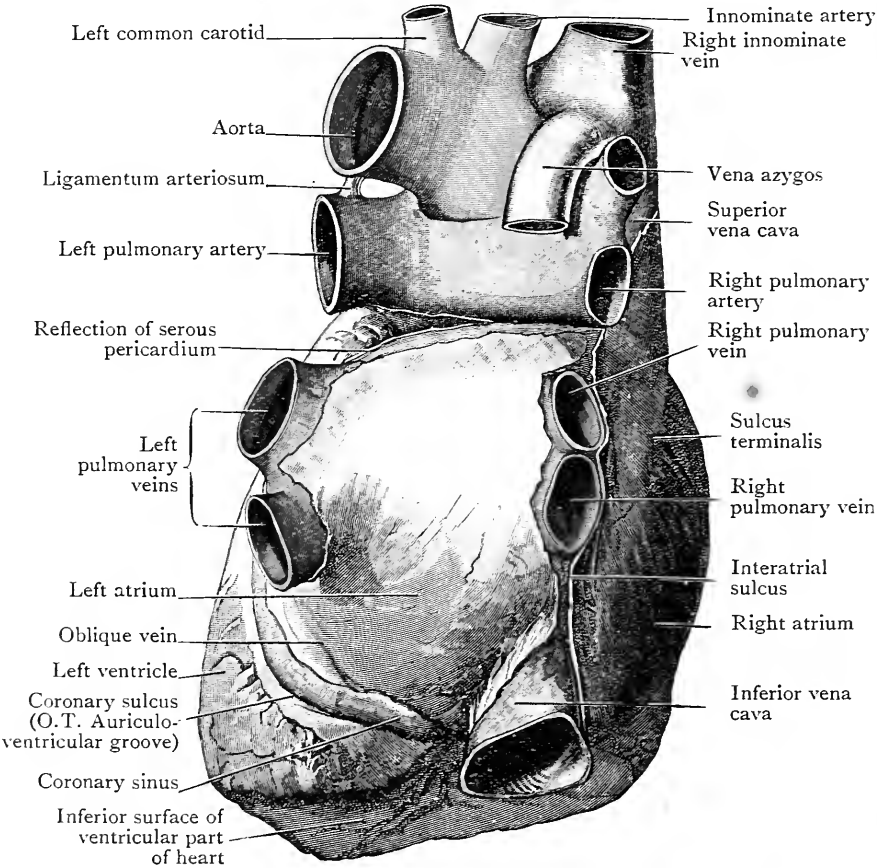

FIG. 59.—Posterior or Basal Aspect of a Heart hardened *in situ* by formalin injection.

The posterior wall of the left atrium is of quadrangular outline. Along its superior border lie the right and left pulmonary arteries. It is bounded inferiorly by the posterior part of the coronary sulcus, in which lies the coronary sinus, and on the right by an indistinct *interatrial sulcus*, which indicates the position of the posterior border of the interatrial septum. Descending obliquely across the posterior wall of

the left atrium, from the lower border of the left inferior pulmonary vein, downwards and to the right to the coronary sinus, is the oblique vein (Marshalli), which is the remains of the left duct of Cuvier of the fœtus. Occasionally it becomes the lower end of a left superior vena cava.

Dissection.—Open the left atrium by three incisions—one horizontal and two vertical. The horizontal incision must run from side to side along the lower border of the atrium, immediately above the coronary sulcus ; and the vertical incisions must ascend from the extremities of the horizontal incision to the

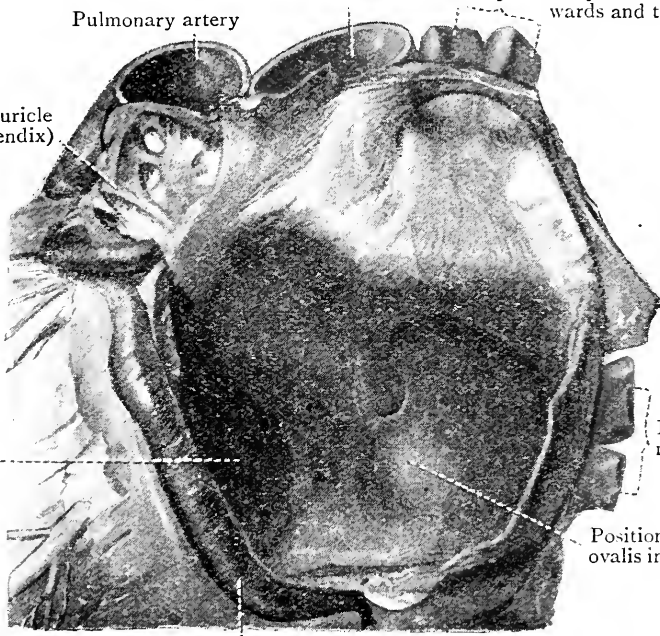

FIG. 60.—The Left Atrium opened from behind. The greater part of the posterior wall has been thrown upwards.

upper border of the posterior surface, each passing to the medial side of the terminations of the corresponding pulmonary veins. When the incisions have been made, the posterior wall of the atrium must be turned upwards whilst the cavity is being examined. From the lower end of the left vertical incision carry the knife forwards, through the lateral wall of the auricle of the left atrium.

The inner surface of the wall of the left atrium is smooth and generally devoid of muscular bundles, but it will be noted that the inner surface of the wall of its auricle (O.T.

auricular appendage) is covered with musculi pectinati. In a formalin hardened heart the dissectors will find a strong muscular ridge which descends from the posterior margin of the commencement of the cavity of the auricle along the left border of the cavity of the atrium anterior to the orifices of the left pulmonary veins, entirely concealing them from view when the cavity is examined from the front.

On the right or septal wall of the left atrium the position of the margin of the valve of the foramen ovale is marked by one or more small semilunar depressions situated between slender muscular ridges. The portion of the septal wall which lies below and posterior to those depressions forms the floor of the fossa ovalis, and is the remains of the valve of the foramen ovale of the fœtus.

The Orifices of the Left Atrium.—The orifices of the left atrium are the openings of the *four pulmonary veins*, the *left atrio-ventricular orifice*, and a number of minute openings which are the mouths of the *venæ cordis minimæ*.

The pulmonary veins convey oxygenated blood from the lungs to the atrium. Through the venæ minimæ cordis a small amount of venous blood, from the walls of the atrium, is passed into its cavity. Through the left atrio-ventricular orifice the blood passes from the left atrium into the left ventricle.

The openings of the pulmonary veins are situated in the posterior wall of the atrium, nearer the upper than the lower part, and close to the lateral borders, two on each side. They are entirely devoid of valves. The orifices of the venæ cordis minimæ, which are scattered irregularly, are also valveless; but the left atrio-ventricular orifice, which lies in the lower part of the anterior wall of the atrium, is guarded by the bicuspid valve, which has been described already (p. 107). The left atrio-ventricular orifice is smaller than the corresponding orifice on the right side, and admits the tips of two fingers only.

The Structure of the Walls of the Heart.—The last step in the dissection of the heart consists in the examination of the structure of its walls. On the outside the walls are covered with the *epicardium*, which is the visceral part of the serous pericardium; and on the inside they are lined with the smooth and glistening *endocardium*, which plays a large part in the formation of the flaps of the valves, and is continuous, through the orifices, with the inner coats of the arteries and veins. Between the epicardium and the endocardium lies the muscular tissue of the heart, which is termed the *myocardium*. The muscular fibres of the myo-

cardium are disposed in layers, in each of which the fibres take a special direction.

The arrangement of the various layers of the myocardium cannot be displayed in an ordinary dissecting-room heart, in which the continuity of the fibres has been destroyed by the incisions made to display the cavities, but the arrangement of the layers is practically the same in the hearts of all mammals. Therefore, for the purpose of studying the layers, the dissectors should obtain a sheep's heart. Fill the heart with a paste made of flour and water; then boil it for a quarter of an hour. The boiling expands the paste, softens the connective tissue, and hardens the muscular fibres. After the boiling is finished the heart should be placed for a time in cold water. After it has cooled, first the epicardium and then the muscular fibres should be gradually torn off.

The atrial fibres are difficult to dissect. They consist of three groups: (1) A superficial group, running more or less transversely and common to both atria. They are best marked near the coronary sulcus. (2) A deep group, special to each atrium. The extremities of the fibres of the deep group are connected with the fibrous atrio-ventricular rings, and they pass over the atria from front to back. (3) The third group consists of sets of annular fibres surrounding the orifices of the veins which open into the atria.

The fibres of the ventricles are more easily dissected. They consist, for the main part, of two groups—the superficial and the deep. The fibres of each set are common to both ventricles, and the dissectors should note the remarkable spiral or whorled arrangement of the superficial fibres which occurs at the apex, where they pass into the deeper parts of the wall.

The superficial fibres spring mainly from the fibrous atrio-ventricular rings. Those which are attached to the right ring turn inwards at the apex and become continuous with the papillary muscles of the left ventricle, whilst the fibres which spring from the left ring pass in the same way to the papillary muscles of the right ventricle. The deeper fibres form an ∽-shaped layer, one loop of the ∽ surrounding the right and the other the left ventricle.

The fibrous rings of the atrio-ventricular orifices intervene between the atrial and the ventricular muscle fibres, but the two groups are brought into association with each other by the atrio-ventricular bundle described on p. 101. It has been assumed that the impulses which regulate the movements of the ventricles were conveyed to them from the atria by the fibres of that bundle, but it has been shown recently that numerous nerve fibrils are intimately intermingled with the fibres of the atrio-ventricular bundle. It is possible, therefore, that the connection between the atria and the ventricles is neuro-muscular.

The Action of the Heart.—The differences between the various parts of the heart, *i.e.* the thinness of the walls of the atria as contrasted with the thickness of the walls of the ventricles, and the greater thickness of the walls of the left as contrasted with those of the right ventricle, are associated with the functions of the various chambers, and with the action which the heart plays in the maintenance of the circulation of the blood. The heart is a muscular pump, provided with receiving and ejecting chambers. It has three phases of action: (1) a period of atrial contraction; (2) a period of ventricular contraction, which immediately succeeds the atrial contraction; (3) a period of diastole or rest.

During the period of diastole or rest the chambers, previously contracted, dilate as the muscular fibres of the heart relax. The dilatation is aided by the respiratory movements of the thorax. As the dilatation progresses blood flows into the right atrium from the superior vena cava, the

inferior vena cava and the coronary sinus; and into the left atrium through the four pulmonary veins. The atrial contraction commences with the contraction of the circular fibres which surround the mouths of the veins entering the atria, and thus the blood is prevented from passing back into the veins. As the contraction extends to the general fibres of the atria the blood is forced onwards into the ventricles, which become distended. Then the ventricular contraction commences, the atrio-ventricular valves close, and, as the contraction proceeds, the blood is driven out of the ventricles through the arterial orifices, that in the right ventricle being ejected into the pulmonary artery, and that in the left ventricle into the aorta.

When the ventricular contraction is completed the period of diastole commences; and, as long as the heart remains alive, the cycle is repeated.

The work of the atria is merely to force the blood through the widely open atrio-ventricular orifices into the ventricles and to expand the dilating walls of the ventricles. For that purpose no great force is required, therefore the walls of the atria are thin. The work of the ventricles is much more severe, therefore their walls are thicker. The right ventricle, however, has only to exert sufficient force to drive the blood through the lungs to the left atrium, that is, through a comparatively short distance and against a comparatively small resistance; therefore its walls are thin as compared with the walls of the left ventricle, which have to be sufficiently strong to force the blood through the whole of the trunk, the head and neck, and the upper and lower limbs.

The Topography of the Heart.—Before proceeding to the study of the trachea, the dissectors should replace the heart in position and revise their knowledge of its relations to the surface. Its position can be indicated on the anterior wall of the thorax by the following four lines:—(1) A line commencing at the lower border of the second left costal cartilage, 13 mm. (half an inch) from the left border of the sternum, and ending at the upper border of the third right costal cartilage, about 13 mm. (half an inch) from the right border of the sternum. The line so drawn will indicate the position of the upper border of the heart, which is formed by the upper ends of the atria. (2) A line from the upper border of the third right costal cartilage to the sixth right costal cartilage. That line should commence and end about 13 mm. (half an inch) from the border of the sternum, and should be slightly convex to the right. It indicates the right border of the heart, which is formed by the right atrium alone. (3) A line from the sixth right costal cartilage to the apex, which lies behind the fifth left intercostal space, about 88 mm. (three and a half inches) from the median plane. That line marks the position of the lower border of the sterno-costal surface, which is formed, in the greater part of its extent, by the right ventricle, the left ventricle entering into its constitution only in the region of the apex.

(4) A line from the apex to the lower border of the second left costal cartilage. This line should be convex upwards and to the left; the point of greatest convexity should coincide with the lower border of the fourth left costal arch, and the upper

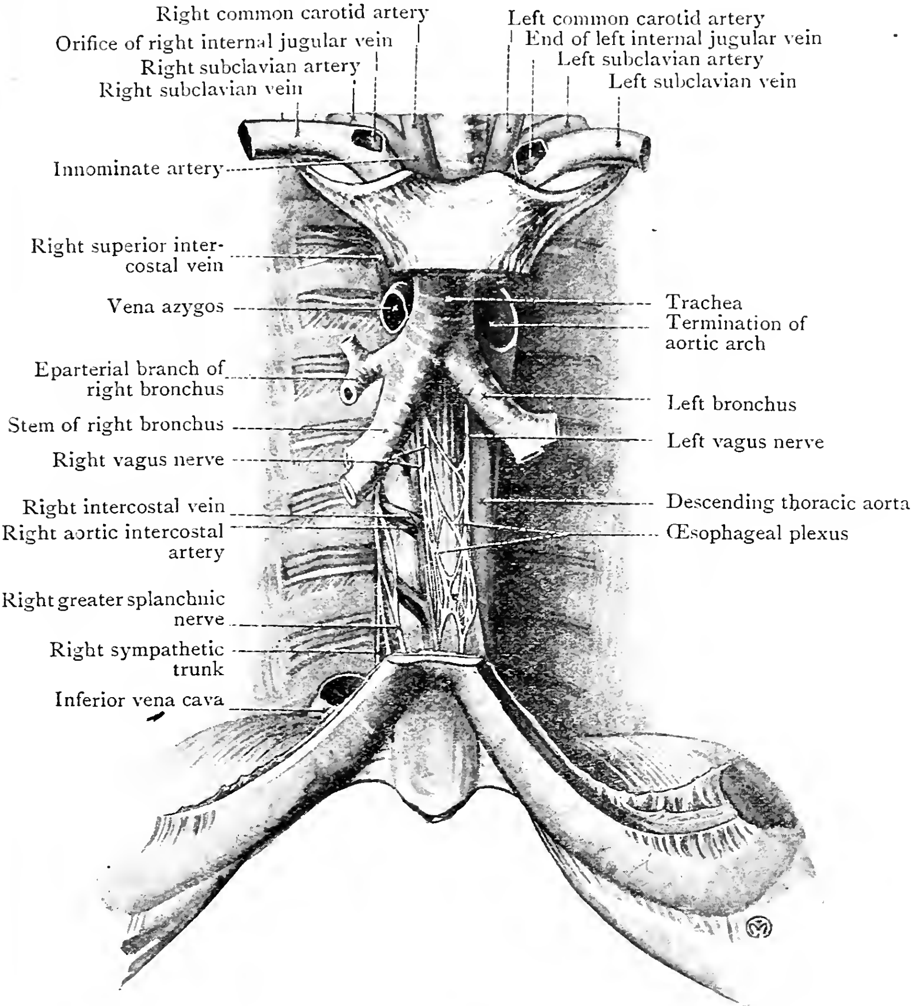

FIG. 61.—Dissection of the Posterior Mediastinum and the posterior part of the Superior Mediastinum, from the anterior aspect.

extremity should be situated about 13 mm. (half an inch) from the left margin of the sternum. It marks the position of the left border of the heart, which is formed in the lower four-fifths of its length by the left ventricle and in the remaining fifth by the left atrium.

A line from the upper border of the sternal end of the

third left costal cartilage to the lower border of the sternal end of the sixth right cartilage indicates the anterior part of the coronary sulcus. The points indicating the positions of the arterial and atrio-ventricular orifices must be placed immediately below the line of the coronary sulcus in the following order from above downwards: *pulmonary orifice*, *aortic orifice*, *mitral orifice*, *tricuspid orifice*. The centre of the pulmonary orifice is posterior to the third left costal cartilage

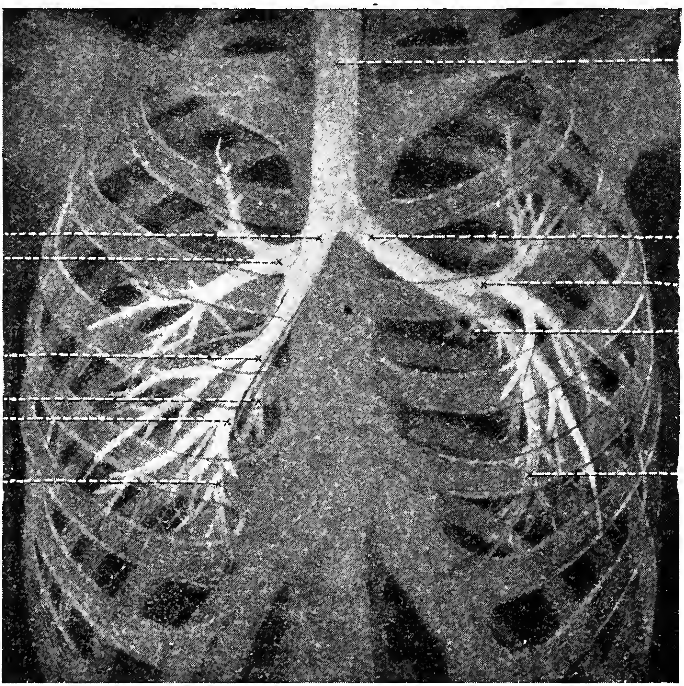

Fig. 62.—Drawing of a Stereoscopic Skiagraph of the Trachea and Bronchi injected with starch and red lead.

at the margin of the sternum. The aortic orifice lies posterior to the left half of the sternum opposite the third intercostal space. The mitral orifice is posterior to the left border of the sternum at the level of the fourth left costal cartilage; and the centre of the tricuspid orifice is posterior to the middle of the sternum at the level of the fourth intercostal spaces.

The Thoracic Portion of the Trachea.—The thoracic portion of the trachea, like the cervical portion, is a wide tube kept constantly patent by a series of curved cartilaginous bars which are embedded in its walls. The bars are

deficient posteriorly, and, in consequence, the tube is flattened behind (Fig. 57). It enters the thorax at the upper aperture, posterior to the upper border of the manubrium, and it terminates, at the level of the lower border of the manubrium and the upper border of the fifth thoracic vertebra, by dividing into a right and a left bronchus. It lies, therefore, in the superior mediastinum, and its median axis is in the median plane, except at the lower end, where it deviates slightly to the right.

Relations.—*Posteriorly*, it is in contact with the œsophagus, which separates it from the vertebral column; and in the angle between its left border and the anterior surface of the œsophagus is the left recurrent nerve (Fig. 57).

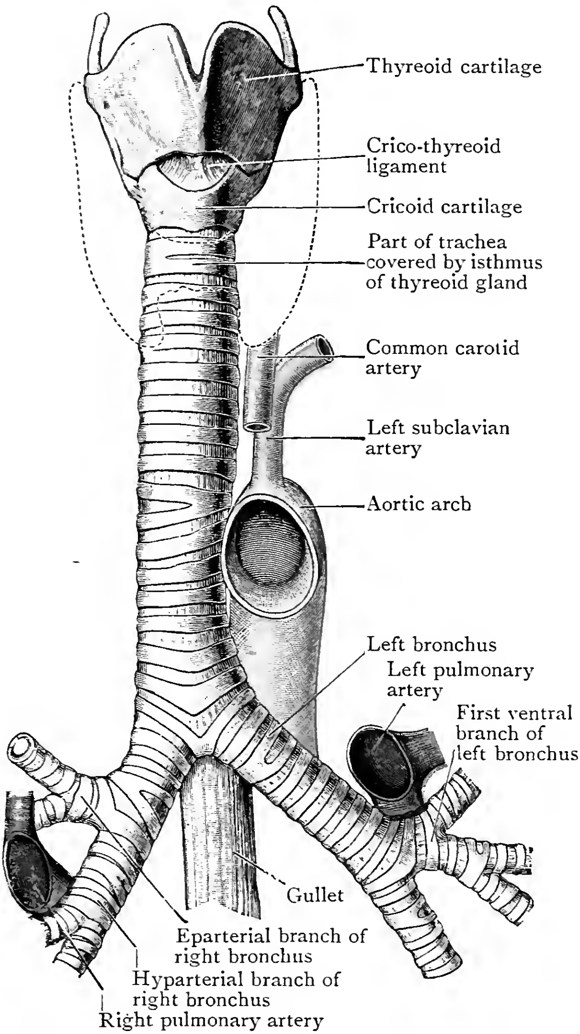

FIG. 63.—The Trachea and Bronchi. The dotted line gives the outline of the thyreoid gland.

Anteriorly, it is in relation, below, with the arch of the aorta, the deep part of the cardiac plexus intervening; and, at a higher level, with the innominate and left common carotid arteries, the left innominate vein and the inferior thyreoid veins. More superficially lie the remains of the thymus, and still more superficially the manubrium sterni

with the origins of the sterno-hyoid and sterno-thyreoid muscles, which are attached to it.

On the right, it is in relation with the upper part of the mediastinal surface of the right pleura and lung (Fig. 57), the right vagus nerve, and the arch of the azygos vein (Fig. 13). It is also in relation, on its right side, near its lower end and more anteriorly, with the superior vena cava, and, at a higher level, with the innominate artery.

Its *left relations* are the arch of the aorta, below, and the left subclavian and left common carotid arteries, above.

Bronchi.—Each bronchus passes downwards and laterally, first to the hilum of the corresponding lung, and thence downwards in the substance of the lung to its lower end. It can, therefore, be divided into an extra-pulmonary and an intra-pulmonary portion. The extra-pulmonary part, like the trachea, is kept permanently open by the presence of curved cartilaginous bars in its walls; and as the bars are deficient posteriorly, the extra-pulmonary part of each bronchus presents a flattened posterior surface similar to that of the trachea. The lumina of the intra-pulmonary parts of the bronchi are kept patent by cartilaginous plates which are irregularly distributed in the substance of the walls.

Relations of the Extra-pulmonary Part of the Right Bronchus.—The right bronchus is much more vertical than the left (Fig. 62), and, as the ridge which separates the orifices of the two bronchi at their origins lies to the left of the median line of the trachea, the right bronchus is the more direct continuation of the trachea, and foreign bodies which have entered the windpipe pass more frequently into it than into the left bronchus. It passes downwards and laterally from the upper border of the fifth thoracic vertebra to the level of the upper part of the sixth thoracic vertebra, where it enters the hilum of the right lung. *Anterior to* the extra-pulmonary part of the right bronchus are the ascending part of the aorta, the lower part of the superior vena cava, and the right pulmonary artery. *Above it* is the arch of the azygos vein; and *posterior to it* are the azygos vein, the posterior pulmonary plexus, and the right bronchial artery. The extra-pulmonary part of the right bronchus gives off one branch, which arises close to the hilum and is called the eparterial bronchus, because it originates immediately above

PLATE III

FIG. 64.—Radiograph of Thorax in expiration, showing the positions of the heart, the great vessels and the bronchi.
(Dr. Robert Knox.)

the point where the right pulmonary artery crosses anterior to the stem bronchus.

Relations of the Extra-pulmonary Part of the Left Bronchus.—The extra-pulmonary part of the left bronchus commences and ends at the same level as the corresponding part of the right bronchus, but it has further to go, because the hilum of the left lung is further from the median plane than the hilum of the right lung; therefore, it is longer and less vertical than the right bronchus. It gives off no branches.

Anterior to it are the left pulmonary artery, and the upper and left part of the pericardial sac which separates the bronchus from the left atrium. *Above it* is the arch of the aorta; and *posterior to it* are the descending aorta, the posterior pulmonary plexus, the left bronchial arteries, and the œsophagus.

The intra-pulmonary parts of the bronchi and their relations have already been examined (p. 60). Their positions in relation to the heart are shown in Plate III., Fig. 64.

The Thoracic Portions of the Vagi Nerves.—The thoracic parts of the vagi nerves, which are still in position, should now be examined. Both vagi enter the thorax at the upper aperture.

The right vagus descends, through the superior mediastinum, posterior to the right innominate vein and the superior vena cava, passing obliquely downwards and backwards (Fig. 13) along the side of the trachea, and between the trachea medially, and the right pleura laterally, as far as the arch of the azygos vein. Next, it passes between the trachea medially, and the arch of the azygos vein laterally, and reaches the posterior aspect of the root of the right lung, where it breaks up into a number of branches which unite with branches of the sympathetic trunk to form the posterior pulmonary plexus. It emerges from the plexus usually as a single trunk which runs downwards and medially, in the posterior mediastinum, to the œsophagus. On the œsophagus it breaks up into branches which unite with branches of the left vagus to form the *œsophageal plexus* (Fig. 61). At the lower end of the thorax the right vagus again becomes a single trunk; it passes to the posterior aspect of the œsophagus and enters the abdomen through the œsophageal orifice of the diaphragm.

Thoracic Branches of the Right Vagus.—Whilst the right vagus is in the superior mediastinum it gives off a thoracic

cardiac branch, which goes to the right half of the deep cardiac plexus, and some anterior pulmonary branches to the front of the root of the right lung, where they join with branches of the cardiac plexus to form the anterior pulmonary plexus. As it passes posterior to the root of the lung it gives branches to the bronchi and the lung; and in the posterior mediastinum it gives branches to the œsophagus, and to the posterior part of the pericardium and pleura.

The Left Vagus.—As the left vagus descends through the superior mediastinum it lies first behind the left common carotid artery, and behind the left phrenic nerve which crosses from left to right in front of it, and it is in front of the left subclavian artery. Then it passes across the left side of the arch of the aorta. In the latter situation it is crossed laterally by the left superior intercostal vein. Below the lower border of the aortic arch it passes posterior to the root of the left lung, where it breaks up into branches which enter into the formation of the posterior pulmonary plexus. At the lower border of the root of the left lung it emerges from the plexus as two trunks, which descend, into the posterior mediastinum, to the œsophagus, where they unite with branches of the right vagus to form the *œsophageal plexus.* At the lower end of the thorax the left vagus again becomes a single trunk, which passes through the œsophageal orifice of the diaphragm on the anterior aspect of the œsophagus.

Thoracic Branches of the Left Vagus.—In the superior mediastinum, whilst it lies against the left side of the aortic arch, it gives off the left recurrent branch, branches to the upper and anterior part of the pericardium, and branches to the left anterior pulmonary plexus. Posterior to the root of the left lung, it supplies branches to the left bronchus and the left lung; and during its course through the posterior mediastinum, as it takes part in the œsophageal plexus, it gives branches to the œsophagus, to the posterior part of the pericardium, and to the left pleura.

The Thoracic Part of the Left Recurrent Nerve.—The left recurrent nerve springs from the trunk of the left vagus near the lower border of the left side of the aortic arch. It curves round the lower border of the arch, posterior to and to the left of the ligamentum arteriosum, and passes upwards, behind and to the right of the arch, through the superior mediastinum, in the angle between the

left border of the trachea and the œsophagus, and posterior to the left common carotid artery. As it turns round the arch it gives branches to the deep cardiac plexus, and, as it ascends along the left border of the trachea, it gives offsets to the trachea and to the œsophagus.

The Deep Cardiac Plexus.—The deep cardiac plexus lies between the arch of the aorta and the bifurcation of the trachea. It is more or less distinctly separable into right and left parts, and the right part is connected with the superficial cardiac plexus. The right part of the plexus receives—(1) three cardiac branches from the cervical part of the right sympathetic trunk; (2) the two cervical cardiac branches of the right vagus; (3) the cardiac branch of the right recurrent nerve; (4) the thoracic cardiac branch of the right vagus. It is connected with the superficial cardiac plexus, and it gives branches to—(1) the right anterior pulmonary plexus; (2) the right atrium; (3) the right coronary plexus. The left part of the deep cardiac plexus receives—(1) the middle and lower cervical cardiac branches of the left sympathetic trunk; (2) the upper cervical cardiac branch of the left vagus; (3) the cardiac branches of the left recurrent nerve. It gives branches to—(1) the left anterior pulmonary plexus; (2) the left atrium; (3) the left coronary plexus.

Dissection.—**Cut through the right and left bronchi, close to their origins from the trachea; then divide the trachea at the upper aperture of the thorax and remove its thoracic portion, but avoid injury to the vagi and the left recurrent nerves. The extra-pulmonary parts of the bronchi will be retained in position by the bronchial arteries and the branches of the pulmonary plexuses; and the thoracic part of the œsophagus will be fully exposed.**

The Thoracic Part of the Œsophagus.—The thoracic part of the œsophagus enters the thorax at the upper aperture, passes downwards, through the superior and posterior mediastina, and leaves, at the level of the tenth thoracic vertebra, by passing through the œsophageal orifice of the diaphragm into the epigastric region of the abdomen. As it enters the superior mediastinum it lies somewhat to the left of the median plane, but as it descends it passes medially, gains the median plane at the level of the fifth thoracic vertebra, and continues downwards in that plane to the level of the seventh thoracic vertebra. There it passes forwards

and to the left, across the anterior aspect of the descending aorta and posterior to the pericardium (Figs. 65, 66, 68).

Posterior Relations.—In the superior mediastinum it is anterior to the left longus colli muscle and the vertebral column. In the upper part of the *posterior mediastinum* it is separated from the vertebral column by—(1) the posterior part of the œsophageal plexus, (2) the upper five right aortic intercostal arteries, (3) the thoracic duct, (4) the vena azygos, (5) the vena hemiazygos and the accessory hemiazygos vein; and in the lower part by (6) the œsophageal plexus and (7) the descending aorta.

Anterior Relations.—Anterior to it, *in the superior mediastinum*, lie the trachea, the left recurrent nerve, the upper part of the left common carotid artery, the left subclavian artery, the arch of the aorta, and the structures which lie still further forwards (pp. 35, 64). *As it passes from the superior to the posterior mediastinum* its anterior relations are first the commencement of the left bronchus and then the right pulmonary artery.[1] *In the posterior mediastinum*, the œsophageal plexus is on its anterior surface, intervening between it and the posterior wall of the pericardium, which separates both the plexus and the œsophagus from the posterior wall of the left atrium; and at a lower level the œsophagus lies posterior to the diaphragm (Fig. 69).

Right Relations.—In the superior mediastinum, it is in relation with the right pleura and lung, and with the arch of the vena azygos (Figs. 22 and 13); and, *in the posterior mediastinum*, with the œsophageal plexus and right pleura and lung, until it passes forwards and towards the left, anterior to the descending aorta (Figs. 68, 69).

Left Relations.—In the superior mediastinum, it is in relation on the left side with the thoracic duct, the left subclavian artery, the left pleura and lung, and the termination of the arch of the aorta. *From the fifth to the seventh thoracic vertebra* its left lateral relations are the œsophageal plexus and the descending aorta; *its lower part*, which lies in front of the descending aorta, is in relation on the left side with the left pleura and lung.

The dissector should note (1) that, after death, the œsophagus is generally somewhat compressed antero-posteriorly by the structures between which it lies; it probably has a

[1] Verify this statement by replacing the heart *in situ* (see also Figs. 48, 56).

PLATE IV

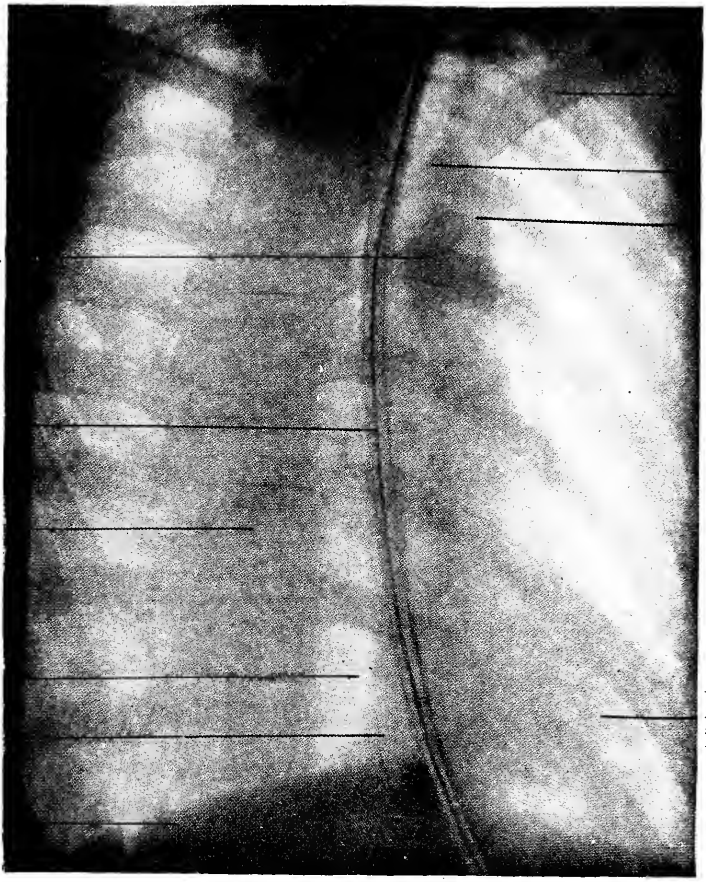

FIG. 65.—Radiograph of Thorax. Oblique view showing the "post-cardiac space."

The "post-cardiac space" lies behind the base of the heart, and more particularly behind the left atrium. The thoracic part of the descending aorta and the œsophagus pass through it. (Goldesbrough.)

PLATE V

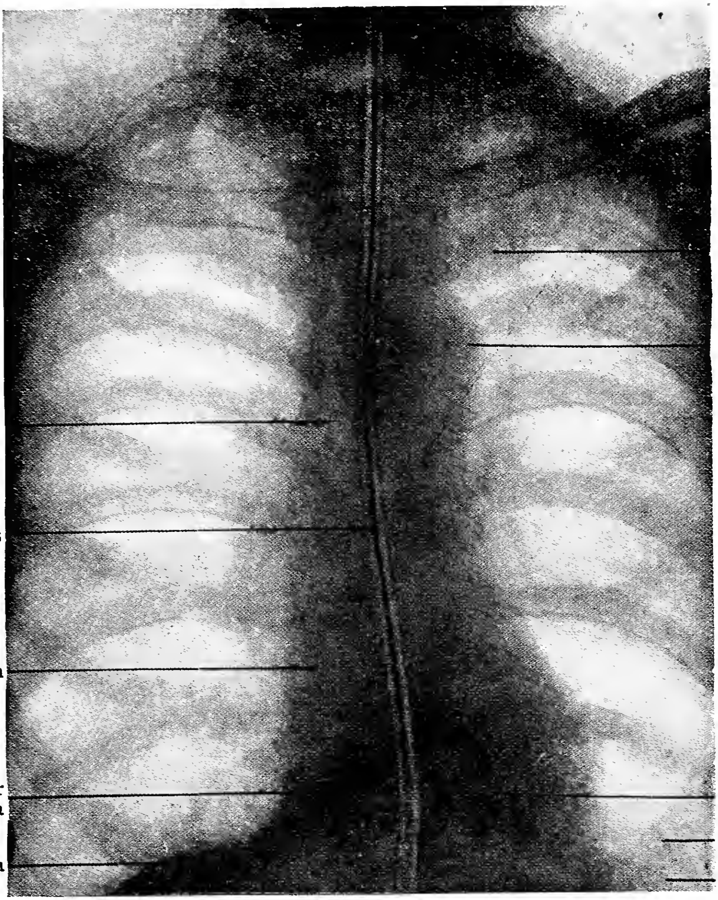

FIG. 66.—Radiograph of the Thorax, showing the position of the Œsophagus into which a bougie with a metal core had been inserted. Anterior view. (Goldesbrough.)

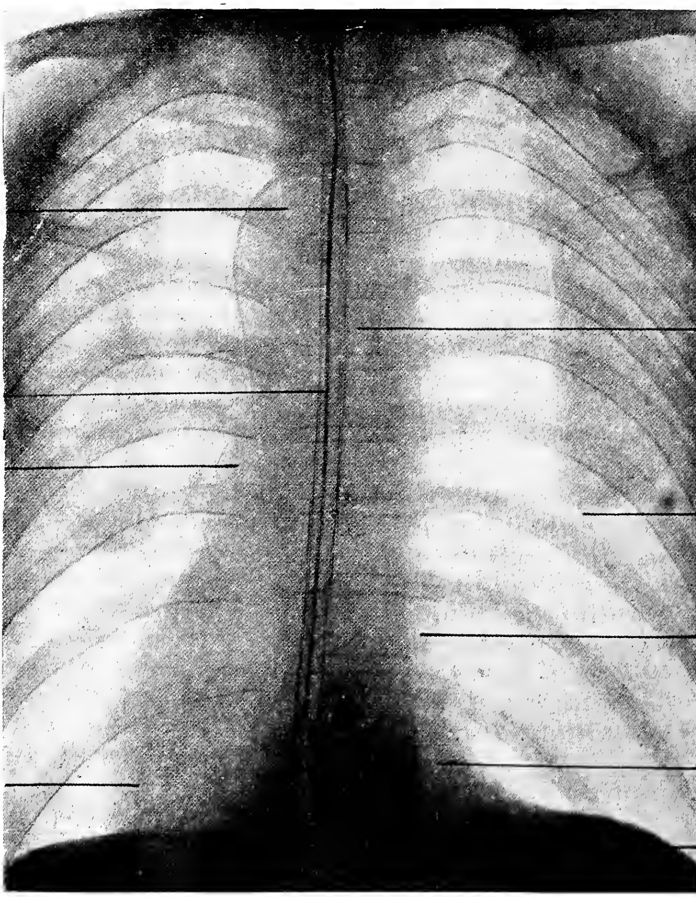

FIG. 67.—Radiograph of Thorax, showing the position of the Œsophagus into which a bougie with a metal core had been inserted. Posterior view. (Goldesbrough.)

similar form during life when empty and flaccid, but becomes more circular when solids or fluids are passing along it;[1] and (2) that it is somewhat constricted at the level of the left bronchus.

An inch or more of the upper part of the posterior mediastinal portion of the tube should be removed and dissected under water in a cork-lined tray. It will be found to possess from without inwards the following coats: (1) an external fibrous sheath; (2) a muscular coat; (3) a submucous coat; and (4) a mucous internal lining. The submucous coat forms a loose connection between the muscular and mucous coats; consequently, when the muscular

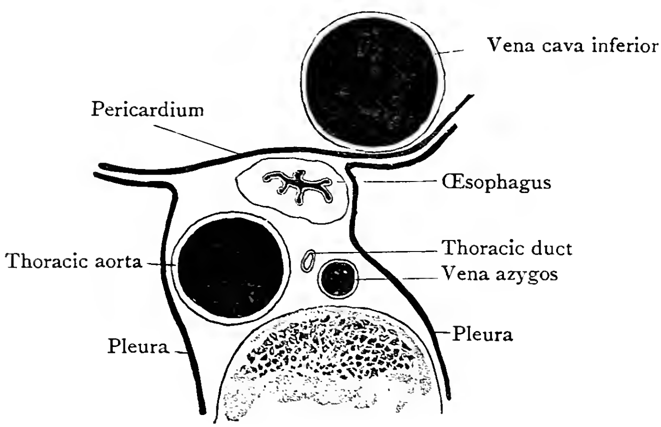

FIG. 68.—Tracing of section through the Posterior Mediastinum at the level of the eighth thoracic vertebra.

coat is contracted the mucous lining is thrown into longitudinal folds. The muscular coat consists of an external layer of longitudinal fibres and an internal layer of circular fibres.

Aorta Descendens.—The descending aorta commences at the termination of the aortic arch, at the lower border of the left side of the fourth thoracic vertebra. It passes downwards, through the posterior mediastinum, and it leaves the thorax by passing through the aortic aperture of the diaphragm, opposite the lower border of the twelfth thoracic vertebra. Its length varies with the length of the thorax but averages from 17·5 to 20 cm. (seven to eight inches). In the upper

[1] It may be dilated after death, see Figs. 47, 48, 54.

part of its extent it lies to the left of the vertebral column; but in the lower part of the thorax it lies anterior to the column, in the median plane (Figs. 56, 54, 47, 48).

Branches.—Branches spring both from the anterior and the posterior aspects of the descending thoracic aorta. Those from the anterior aspect are the two left bronchial arteries, four œsophageal branches, and some small and irregular mediastinal and pericardial branches. The posterior branches are nine pairs of aortic intercostal arteries and one pair of subcostal arteries.

Relations.—*Anterior to* the thoracic part of the descending aorta, from above downwards, are the root of the left lung;

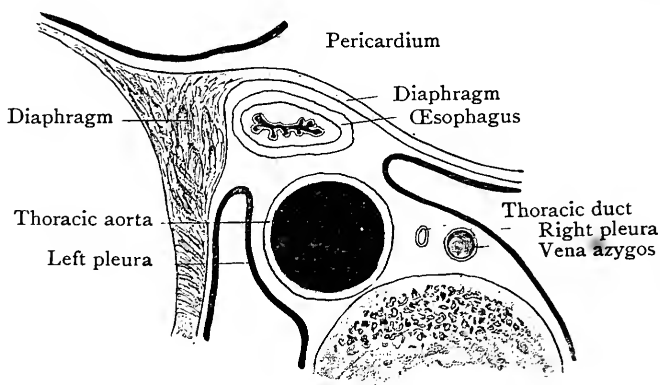

FIG. 69.—Tracing of a section through the lower part of the Posterior Mediastinum, where its anterior wall is formed by the diaphragm.

the upper part of the posterior wall of the pericardium, separating the aorta from the left atrium; the œsophagus, separating the aorta from the lower part of the posterior wall of the pericardium; and the crura of the diaphragm, which separate the lower portion of the thoracic aorta from the omental bursa of the peritoneum and from the posterior surface of the caudate lobe (O.T. Spigelian) of the liver (Fig. 28). *Posteriorly* are the vertebral column, its own intercostal and subcostal branches, the hemiazygos and accessory hemiazygos veins; and it is overlapped posteriorly in the upper part of its extent by the left pleura and lung. *Along its right side*, in its whole length, are the thoracic duct and the vena azygos, and anterior to them, from the fifth to the lower part of the seventh thoracic vertebra, lies the œsophagus. At a lower level a mass of areolar tissue separates the aorta from the

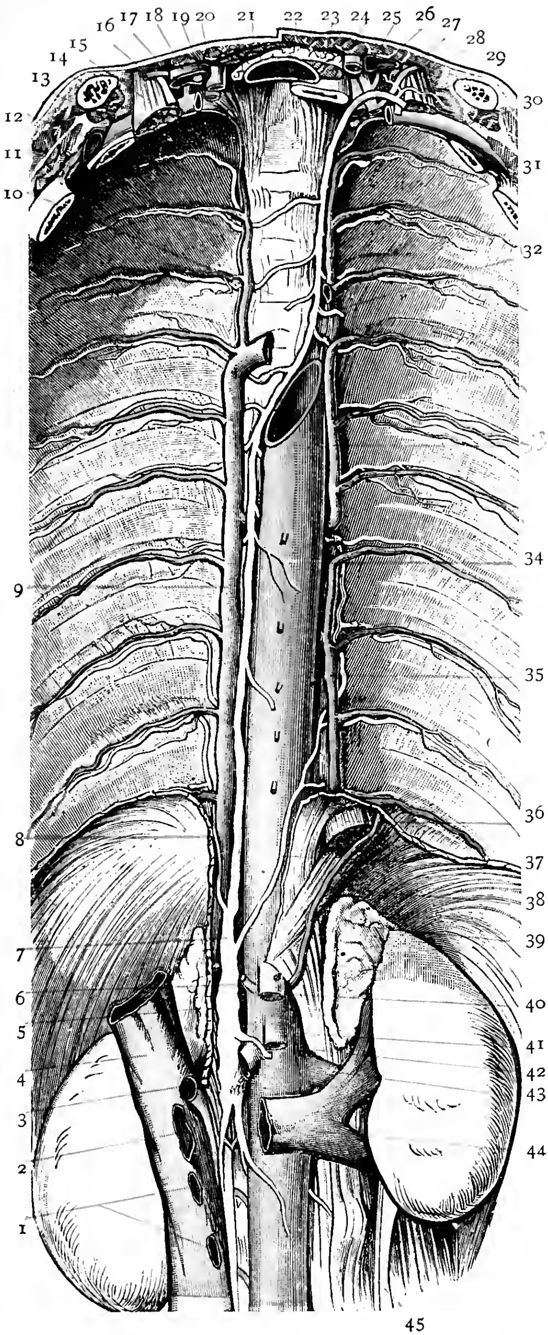

FIG. 70.—The Thoracic Duct and its Tributaries.

1. Lumbar veins.
2. Left renal vein.
3. Right renal artery.
4. Inferior vena cava.
5. Suprarenal gland.
6. Cisterna chyli.
7. Thoracic duct.
8. Descending thoracic lymph trunk.
9. Vena azygos.
10. Mediastinal lymph vessel.
11. Superior intercostal vein.
12. Subclavian vein.
13. Subclavian artery.
14. Clavicle.
15. Scalenus anterior muscle.
16. Phrenic nerve.
17. Thyreo-cervical trunk.
18. Internal jugular vein.
19. Vertebral artery.
20. Common carotid artery.
21. Trachea.
22. Thyreoid gland.
23. Œsophagus.
24. Common carotid artery.
25. Internal jugular vein.
26. Vertebral artery.
27. Thyreo-cervical trunk.
28. Common lymph trunk from head and upper limb.
29. Scalenus anterior muscle.
30. Subclavian artery.
31. Superior intercostal vein.
32. Bronchial lymph vessel.
33. Vena hemiazygos accessoria.
34. Aorta.
35. Vena hemiazygos.
36. Œsophagus.
37. Descending thoracic lymph trunk.
38. Inferior phrenic artery.
39. Suprarenal gland.
40. Cœliac artery.
41. Superior mesenteric artery.
42. Common intestinal lymph trunk.
43. Renal artery.
44. Renal vein.
45. Common lumbar lymph trunk.

right pleura and lung. *On its left side* it is in relation with the left pleura and lung.

Dissection.—Divide the œsophagus at the level of the upper border of the arch of the aorta, and turn the lower part downwards towards the diaphragm. Clean the thoracic duct, the right aortic intercostal arteries, and the hemiazygos and accessory hemiazygos veins, which lie posterior to the œsophagus. Then trace the thoracic duct in the whole of the thoracic portion of its course, and arrange with the dissector of the head and neck to display the cervical portion of its course.

Ductus Thoracicus.—The thoracic duct is a vessel of small calibre but of great importance, for it conveys, to the left innominate vein, the whole of the lymph from the lower extremities, the abdomen (except that from part of the upper portion of the liver), the left side of the thorax (including the left lung and pleura and the left side of the heart), the left upper extremity, and the left side of the head and neck. It is the upward prolongation of a dilated sac—the *cisterna chyli*—which lies between the right crus of the diaphragm and the bodies of the first and second lumbar vertebræ. It enters the thorax through the aortic orifice of the diaphragm, lying between the aorta on the left and the vena azygos on the right. It continues upwards through the posterior mediastinum, lying between the descending aorta and the vena azygos, anterior to the right aortic intercostal arteries and the hemiazygos and accessory hemiazygos veins, and posterior to the right pleura, below, and the œsophagus, above. At the level of the fifth thoracic vertebra it crosses to the left of the median plane, and then ascends, through the superior mediastinum, along the left border of the œsophagus, in contact, on the left, with the left pleural sac, and separated posteriorly from the left longus colli muscle by a quantity of areolar tissue. Anterior to the thoracic duct, in the superior mediastinum, are the termination of the aortic arch, the left subclavian, and the left common carotid arteries, in that order from below upwards. At the upper end of the thorax the thoracic duct enters the root of the neck, and, at the level of the seventh cervical vertebra, it turns laterally, posterior to the left common carotid artery, the left vagus nerve, and the left internal jugular vein, and anterior to the vertebral artery and veins, the thyreo-cervical trunk or inferior thyreoid artery, and the phrenic nerve. Then, turning downwards, forwards

and medially, on the anterior aspect of the scalenus anterior, it crosses anterior to the transverse cervical and transverse scapular arteries, and crossing the subclavian artery it terminates in the upper end of the innominate vein, in

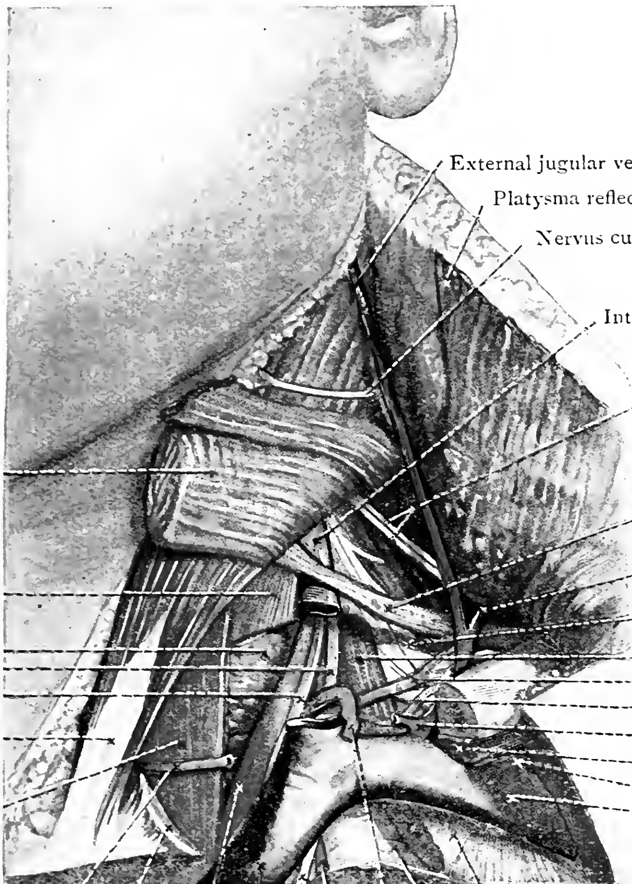

FIG. 71.—Dissection of the Root of the Neck showing the termination of the Thoracic Duct.

the angle of junction of the internal jugular and subclavian veins. Immediately before its termination it receives the left common jugular and subclavian lymphatic trunks, unless they end separately in one or other of the three large veins. When the thoracic duct is distended it has

a beaded or nodulated appearance on account of the numerous valves which lie in its interior. The terminal valve is usually situated a short distance from the point of entrance of the duct into the left innominate vein.

The Right Lymph Duct.—From the level of the fifth thoracic vertebra a small lymph vessel, the *broncho-mediastinal lymph trunk*, may be traced upwards along the front of the vertebral column to the root of the neck. At its commencement in the superior mediastinum it not uncommonly communicates with the thoracic duct. It either ends in the commencement of the right innominate vein, or it joins with the right jugular and right subclavian trunks, to form a short stem, the *right lymph duct*; but, as a rule, the three trunks open separately into the subclavian, the internal jugular, or the innominate vein (Parsons). The right broncho-mediastinal trunk conveys lymph from the upper part of the right lobe of the liver, the right side of the thorax, including the right pleura and lung and the right half of the heart, and, if a right lymphatic duct is formed it receives the lymph from the right upper extremity and the right side of the head and neck as well as the lymph carried by the broncho-mediastinal trunk.

Lymphoglandulæ Thoracales.—During the dissection of the thorax the dissector will have noted certain groups of lymph glands. These are of considerable importance, for their enlargement in disease is not infrequently the cause of serious thoracic trouble; but whilst some, such as the broncho-pulmonary and tracheo-bronchial glands, are quite obvious, others are frequently so small that they escape notice. The following are the chief groups:—(1) Two chains of minute glands which are placed in relation to the anterior thoracic wall along the course of the internal mammary vessels. They are termed *sternal lymph glands*, and are joined by lymph vessels from the anterior thoracic wall, the mammary glands, the anterior part of the diaphragm, and the upper part of the anterior wall of the abdomen. (2) Two chains of glands on the posterior thoracic wall—one on each side of the vertebral column in relation to the posterior parts of the intercostal spaces and the vertebral extremities of the ribs. These are very minute; they are called the *intercostal lymph glands*, and they receive the lymph vessels of the posterior thoracic wall. (3) *Lower anterior mediastinal lymph glands*, two or three in number, which receive lymph from the diaphragm and upper surface of the liver. They occupy the lower open part of the anterior mediastinum. (4) *Upper anterior mediastinal lymph glands*, an important group, eight to ten in number, and placed in relation to the aortic arch and the great vessels. They receive lymph from the heart, the pericardium, and the thymus. (5) *Posterior mediastinal lymph glands*, which follow the course of the thoracic aorta, and are joined by lymph vessels from the diaphragm-pericardium and œsophagus. (6) *Tracheo-bronchial* and *intertracheo*,

bronchial lymph glands, associated with the intra-thoracic part of the trachea and the extra-pulmonary parts of the bronchi and the visceral pleura. (7) *Broncho-pulmonary lymph glands*, which lie in the hila of the lungs. (8) *Pulmonary lymph glands*, which are situated in the angles of division of the bronchi in the substance of the lung. The lymph from the lungs and the visceral pleura passes through the pulmonary, broncho-pulmonary, tracheo-bronchial, and intertracheo-bronchial glands, on the way towards the terminal lymph vessels. As it traverses the glands the carbon particles, which have passed from the air in the pulmonary alveoli and then through the walls of the alveoli and the walls of the lymph capillaries into the lymph in the lymph capillaries, are removed from the lymph by the cells of the lymph glands, and are deposited in their substance and in the stroma of the glands which, as a consequence, gradually become blacker and blacker as life continues.

Dissection.—Cut through the descending aorta immediately above the diaphragm. Detach its upper end from the left vagus and the left recurrent nerve, which were previously fastened to it; then draw it forwards and divide the intercostal and subcostal arteries, which arise from its posterior surface, close to their origins, and remove the aorta. The lateral parts of the aortic intercostal arteries have already been displayed (p. 40). Now clean their most medial parts and the transverse parts of the hemi-azygos and accessory hemiazygos veins. Then proceed to the study of the aortic intercostal arteries and the revision of the intercostal veins and nerves.

Arteriæ Intercostales.—There are eleven pairs of intercostal arteries. The upper two pairs are derived indirectly from the subclavian arteries; the remaining nine pairs are branches of the thoracic part of the descending aorta.

The Aortic Intercostal Arteries.—The nine pairs of aortic intercostal arteries spring from the posterior surface of the descending aorta, either separately or by a series of common trunks, one for each pair. The right arteries are longer than the left because the aorta lies to the left of the median plane; and, since the descending aorta commences only at the level of the lower border of the fourth thoracic vertebra, the four or five highest pairs have to ascend to gain the level of the spaces to which they are distributed (Figs. 13 and 14).

The *right aortic intercostal arteries* run across the anterior aspects of the bodies of the vertebræ, lying posterior to the thoracic duct and the vena azygos; then they turn backwards, between the sides of the bodies of the vertebræ and the parietal pleura; and, finally, immediately before they enter the intercostal spaces, they pass between the sides of the bodies of the vertebræ medially and the sympathetic trunk laterally.

The shorter *left aortic intercostal arteries* run backwards, first

between the left pleura and the bodies of the vertebræ, and then between the sympathetic trunk and the vertebral bodies.

As each artery enters the space to which it belongs it gives off a *posterior branch*, which passes backwards, between the vertebral column medially and the anterior costo-transverse ligament laterally; the posterior branch gives off a spinal twig, which enters the vertebral canal through the corresponding intervertebral foramen; then it divides into a medial and a lateral branch which accompany the medial and lateral divisions of the posterior ramus of the corresponding thoracic nerve. After giving off the posterior branch, the trunk of the artery runs laterally, along the upper border of the space to which it belongs, at first anterior to the posterior intercostal membrane, and then between the internal and external intercostal muscles. Its further course has been described already (p. 12). As it passes along the upper border of the intercostal space, in the shelter of the costal groove of the rib, it is situated between the intercostal vein above and the anterior ramus of the thoracic nerve below.

The Subcostal Arteries.—The subcostal arteries are the last pair of branches which spring from the posterior aspect of the thoracic part of the descending aorta. They enter the abdomen by passing behind the lateral lumbo-costal arches, and they run, in company with the last thoracic nerves, along the lower borders of the last pair of ribs in the walls of the abdomen (see p. 408).

Arteriæ Intercostales Supremæ.—The superior intercostal arteries, which supply the upper two intercostal spaces on each side, are derived from the costo-cervical branches of the subclavian arteries (Fig. 6). Each superior intercostal artery commences at the level of the upper border of the neck of the first rib. It descends anterior to the neck of the rib, posterior to the parietal pleura and between the first thoracic ganglion of the sympathetic trunk medially and the first thoracic nerve, which is passing upwards to the brachial plexus, laterally (Fig. 6). At the lower border of the neck of the first rib it gives off the posterior intercostal artery to the first intercostal space; then it crosses anterior to the neck of the second rib, and, turning laterally, it becomes the posterior intercostal artery of the second space.

Nervi Intercostales.—The intercostal nerves are the

anterior rami of the thoracic nerves. They pass laterally, in company with the arteries. The twigs which connect them with the sympathetic ganglia have been noted already (p. 39). Each nerve lies at a lower level than the corresponding artery, and is, at first, placed between the posterior intercostal membrane and the pleura, and then between the two muscular strata. The positions occupied by the majority of the thoracic nerves and their general distribution have already been described (see p. 10), but the first, second, and last nerves of the thoracic region require special consideration.

The *first thoracic nerve* runs upwards, anterior to the neck of the first rib, to join the brachial plexus. It gives a small branch to the first intercostal space, but that branch, although it is disposed after the manner of an intercostal nerve, does not furnish, as a rule, a lateral cutaneous or an anterior cutaneous branch. The *second intercostal nerve*, as a rule, sends a branch upwards, anterior to the neck of the second rib, to join that portion of the first thoracic nerve which enters the brachial plexus. This communicating twig is usually insignificant, but sometimes it is a large nerve; when that is the case, the intercosto-brachial nerve (O.T. intercosto-humeral), or lateral cutaneous branch of the second intercostal nerve, is very small or altogether absent.

The Last Thoracic Nerve.—The twelfth thoracic nerve is distributed to the wall of the abdomen and to the buttock. It emerges from the vertebral canal between the last thoracic and the first lumbar vertebræ, and, almost at once, passes from the thorax to the abdomen behind the lateral lumbocostal arch (see p. 407) accompanying the subcostal artery.

Venæ Intercostales.—The *posterior intercostal veins* differ in their arrangement upon the two sides of the body. On the *right side* they terminate in three different ways:—

1. The highest intercostal vein, from the first or highest space, joins the *right innominate vein* (sometimes the *vertebral vein*), in the neck.
2. The intercostal veins of the second and third spaces (and sometimes that of the fourth space) unite into a common trunk, termed the *right superior intercostal vein*, which joins the upper part of the *vena azygos*.
3. The intercostal veins of the lower eight spaces join the *vena azygos*.

On the *left side* of the body *four* modes of termination may be recognised:—

1. The highest intercostal vein, from the first space, joins the *left innominate vein* (sometimes the *vertebral vein*), in the neck.
2. The intercostal veins of the second and third spaces (and sometimes that of the fourth space) converge and by their union form a single trunk, termed the *left superior intercostal vein*, which crosses the arch of the aorta and joins the *left innominate vein* in the thorax. The union with the left innominate vein may be absent, and then the trunk formed by the veins of the second and third spaces joins the accessory hemiazygos vein.
3. The intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces terminate in the *accessory hemiazygos vein* (O.T. vena azygos minor superior), which crosses posterior to the aorta and joins the hemiazygos vein, or it ends directly in the vena azygos.
4. The intercostal veins of the ninth, tenth, and eleventh spaces join the *hemiazygos vein* (O.T. vena azygos minor inferior).

Vena Azygos (O.T. **Vena Azygos Major**).—The azygos vein has already been studied, but should now be revised (p. 41), and then the dissector should examine the hemiazygos and accessory hemiazygos veins.

Vena Hemiazygos Accessoria.—The accessory hemiazygos vein is formed, on the left side of the body, by the union of the intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces. It communicates above with the left superior intercostal vein, which carries the blood from the second and third intercostal spaces to the left innominate vein; and it receives the left bronchial veins. At the level of the eighth thoracic vertebra it crosses to the right, posterior to the aorta and thoracic duct, and ends by joining either the hemiazygos vein or the vena azygos. It is very irregular both as regards its tributaries and its termination.

Vena Hemiazygos (O.T. **Vena Azygos Minor Inferior**).—The hemiazygos vein takes origin within the abdomen. It is either the continuation upwards of the *left ascending lumbar vein* or it springs from the left renal vein. It enters the thorax by piercing the left crus of the diaphragm, and is continued upwards, upon the vertebral column, as far as the ninth or eighth thoracic vertebra. At that point it turns to the right, and, crossing posterior to the aorta and the thoracic duct, it joins the vena azygos. Before it terminates it may receive the accessory hemiazygos vein.

The thoracic tributaries of this vein are the intercostal veins of the lower three spaces of the left side and the left subcostal vein. In the abdomen it receives the upper two left lumbar veins.

The Anterior Intercostal Veins.—The anterior inter-

costal veins have already been referred to (p. 15). They draw blood from the anterior part of the thoracic wall by veins which accompany the intercostal branches of the internal mammary arteries, and they terminate in the internal mammary veins.

The veins of the thoracic parietes are extremely variable, and the description given above must be looked upon as representing merely their more usual arrangement.

THORACIC JOINTS.

The dissector should now complete the dissection of the thorax by an examination of the various thoracic joints.

> ***Dissection.***—When the portion of the sternum, with the cartilages of the ribs, which was laid aside, is studied, the following joints will be noted: inter-sternal, sterno-costal, and inter-chondral. Very little dissection is necessary. After the ligaments have been defined, the dissector should remove a thin slice from the anterior aspect of each articulation, in order that the interior of the joint may be displayed.

Synchondrosis Sternalis.—The joint between the manubrium and the body of the sternum is a synchondrosis. The opposing surfaces of bone are united by an intervening plate of cartilage. The joint is supported by some anterior and posterior longitudinal fibres which are developed in connection with the strong and thick periosteum. The posterior ligament is the stronger of the two. The joint between the body of the sternum and the xiphoid process is also a synchondrosis till middle life, at which period the two parts become ossified together.

Articulationes Sternocostales.—Seven ribs articulate with each side of the sternum by means of their cartilages.

The articulations of the first and the sixth are peculiar, inasmuch as they articulate with single pieces of the sternum, viz., with the manubrium and the lowest piece of the body, respectively; whereas each of the cartilages of the other true ribs articulates with two segments of the sternum. The cartilage of the first rib is implanted upon the side of the manubrium; there is no synovial cavity and the joint is a synchondrosis. The second costal cartilage is usually separated from the sternum by two synovial cavities, between which an interarticular ligament is developed. In the case of the other joints it is more common to find a single synovial cavity

and no interarticular ligament. There is, however, considerable variety in these articulations, and a synovial stratum is very frequently wanting altogether in the joint between the seventh costal cartilage and the sternum.

With the exception of the first, which is a synchondrosis, the sterno-chondral joints belong to the diarthrodial variety. They are provided with anterior and posterior ligaments, and also, in those cases where the joint presents a double synovial cavity, with an interarticular ligament.

Ligamenta Sternocostalia Radiata.—The radiate sterno-costal ligaments are strong fibrous strands of the articular capsules of the sterno-costal joints. They radiate from the anterior and posterior surfaces of the sternal ends of the costal cartilages, from the second to the sixth, to the adjacent parts of the anterior and posterior surfaces of the sternum.

Ligamenta Sternocostalia Interarticularia.—The interarticular sterno-costal ligaments are feeble bands which attach the tips of the rib cartilages to the sides of the sternum. They divide the cavities of the joints in which they exist into upper and lower compartments each of which is lined with a synovial stratum.

Articulationes Interchondrales.—The interchondral joints are formed between the adjacent margins of the ribs, from the sixth to the tenth. The joint cavities are surrounded by ordinary articular capsules, each of which is lined internally with a synovial stratum; they are, therefore, diarthrodial joints.

Articulationes Costovertebrales.—The costo-vertebral joints are separable into two groups—articulationes capitulorum and articulationes costo-transversariæ.

The capitular articulations are the joints between the heads of the ribs and the bodies of the vertebræ and the intervertebral fibro-cartilages; they are diarthrodial joints. With the exceptions of the first rib and the last three ribs, the head of every rib articulates with the bodies of two adjacent vertebræ and the intervening intervertebral fibro-cartilage, and it is connected with them by an articular capsule and an interarticular ligament. The interarticular ligament connects the intervertebral fibro-cartilage with the ridge which separates the two facets on the head of the rib. It is united, anteriorly and posteriorly, with the capsule, and separates the joint cavity into an upper and a lower compartment. The anterior part

of the capsule is specialised into three radiating bands which form the *radiate ligament* (lig. capituli costæ radiatum). The upper and lower bands go to the corresponding vertebræ, whilst the intermediate band is attached to the intervertebral fibro-cartilage. The capitular joints of the first, and the tenth, eleventh, and twelfth ribs are each formed between the head of the rib and the corresponding vertebra. The interarticular ligament is absent; therefore each joint possesses only one

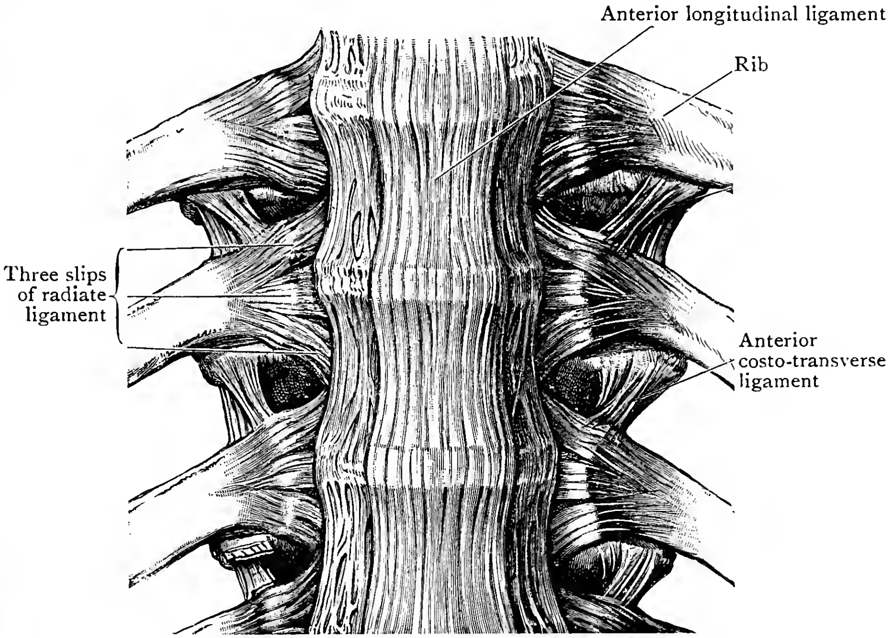

FIG. 72.—Anterior aspect of the Costo-vertebral Joints and of the Anterior Longitudinal Ligament of Vertebral Column.

cavity. The anterior parts of the capsules of those joints are not, as a rule, specialised into radiate bands.

The Costo-transverse Articulations are the joints formed between the necks and tubercles of the ribs and the transverse processes of the vertebræ.

The tubercle of each rib, with the exception of the eleventh and twelfth, articulates with the tip of the transverse process of the vertebra of the same number, by a circular articular facet which is surrounded by an articular capsule lined with a synovial stratum. The joint is, therefore, a diarthrodial joint, and the upper and posterior part of the capsule is greatly thickened, and is called the *ligament of the tubercle*

(lig. tuberculi costæ) (O.T. *posterior costo-transverse ligament*). In addition to the capsule and its posterior thickening, there are three accessory costo-transverse bands, the anterior and posterior costo-transverse ligaments and the ligament of the neck of the rib.

Ligamentum Costo-transversarium Anterius.—The anterior costo-transverse ligament ascends from the anterior margin of the upper border of the neck of the rib to the lower border of the transverse process above.

Ligamentum Costo-transversarium Posterius.—The posterior costo-transverse ligament passes upwards from the posterior part of the upper border of the neck of the rib to the junction of the lamina and the transverse process of the vertebra above.

Ligamentum Colli Costæ.—The ligament of the neck of the rib (O.T. *middle costo-transverse ligament*) connects the posterior aspect of the neck of the rib with the anterior aspect of the transverse process of the vertebra of the same number.

In the case of the eleventh rib the costo-transverse ligaments are rudimentary or absent, and in the case of the twelfth rib they are usually entirely absent.

Intervertebral Articulations.—The *bodies* of the vertebræ are held together by a series of synchondrodial joints, supported anteriorly by an anterior longitudinal ligament, and posteriorly by a posterior longitudinal ligament. The *vertebral arches*, by means of the articular processes, form a series of diarthrodial joints surrounded by articular capsules, each capsule being lined with a synovial stratum. Certain ligaments pass between different portions of the vertebral arches and their processes, viz., the ligamenta flava, between adjacent laminæ, and the inter-transverse, the inter-spinous, and the supra-spinous ligaments.

As the laminæ and the spinous processes of the vertebræ were removed by the dissector of the head and neck when the vertebral canal was opened to display the spinal medulla, the ligamenta flava, the inter-spinous and supra-spinous ligaments cannot be seen at present.

Ligamentum Longitudinale Anterius.—The anterior longitudinal ligament (O.T. *anterior common ligament*) is situated in front of the bodies of the vertebræ, extending from the atlas vertebra above to the first piece of the sacrum below. It consists of stout glistening fibrous bands, which are firmly

attached to the margins of the vertebral bodies and to the intervertebral fibro-cartilages. The most superficial fibres are the longest, and extend from a given vertebra to the fourth or fifth below it. The deeper fibres have a shorter course, and pass between the borders of two or three adjacent vertebræ. The dissectors cannot fail to notice that the origins of the longus colli muscles are closely connected with the upper part of the thoracic portion of the ligament.

Ligamentum Longitudinale Posterius.—The posterior longitudinal ligament (O.T. *posterior common ligament*) covers the posterior aspects of the vertebral bodies, and is therefore within the vertebral canal. It is firmly connected to the margins of the vertebral bodies and to the intervertebral fibro-cartilages, but is separated from the central parts of the bodies by some loose connective tissue and by a plexus of veins. It is narrow where it covers the venous plexus, but widens out opposite the fibro-cartilages. It therefore presents a scalloped or denticulated appearance.

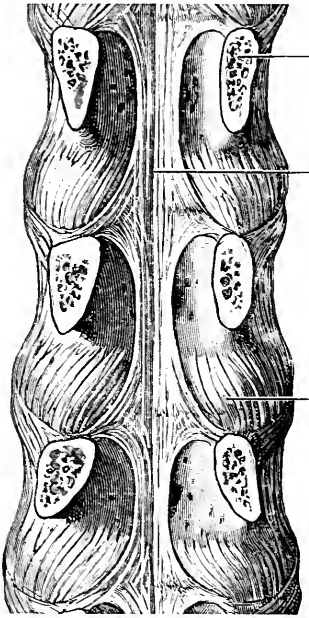

FIG. 73.—Posterior Longitudinal Ligament of the Vertebral Column. The vertebral arches have been removed from the vertebræ.

The *intervertebral fibro-cartilages* are a series of discs of white fibro-cartilage which are interposed between the bodies of adjacent vertebræ. They are thicker posteriorly than anteriorly in the thoracic region. The peripheral part of each disc, the *annulus fibrosus*, is tough and fibrous; the central portion, the *nucleus pulposus*, is soft and pulpy. The discs increase the elasticity of the vertebral column, and tend to restore it to its natural curvature after it has been deflected by muscular action.

The intervertebral fibro-cartilages constitute the main

bond of union between the bodies of the vertebræ, but, except in old people, they are not directly attached to the bone. A thin layer of encrusting hyaline cartilage coats the opposing vertebral surfaces.

Vertical and horizontal sections must be made through two or more of the fibro-cartilages, in order that their structure may be displayed.

Ligamenta Intertransversaria.—The intertransverse ligaments are feeble bands which pass between the tips of the transverse processes. In the lower part of the thoracic region they are intimately blended with the intertransverse muscles: in the middle and upper parts of the thoracic region they entirely replace those muscles.

ABDOMEN.

WHEN the body is brought into the dissecting-room, it is first placed in the lithotomy position (Fig. 75), and is retained in that posture for three days, during which time the dissector of the abdomen must dissect the *perineum*.

MALE PERINEUM.

Boundaries of the Perineum.—The perineum is the region of the inferior end of the trunk between the thighs. It corresponds with the inferior aperture or outlet of the pelvis

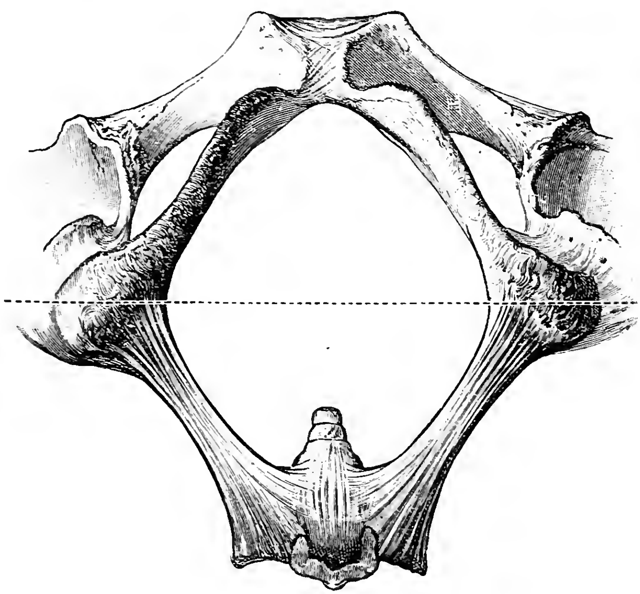

FIG. 74.—Inferior Aperture of Male Pelvis.

and it is necessary, therefore, that the dissectors should renew their acquaintance with that part of the skeleton before they begin the dissection. Having obtained a pelvis, with the ligaments *in situ*, they will note that the inferior aperture of the pelvis is a diamond-shaped space which has the following boundaries: *anteriorly*, the symphysis pubis

and the arcuate pubic ligament (O.T. sub-pubic); *posteriorly*, the coccyx; and *on each side*, from before backwards, the rami of the pubis and ischium, the tuberosity of the ischium, and the sacro-tuberous ligament (O.T. great sciatic). If they now turn their attention to the subject before them they can identify the extent and limits of the space without difficulty. The sacro-tuberous ligament, however, is somewhat obscured, because it is covered by the glutæus maximus muscle, but it can be felt if deep pressure is made in a line between the ischial tuberosity and the coccyx (Figs. 74 and 75).

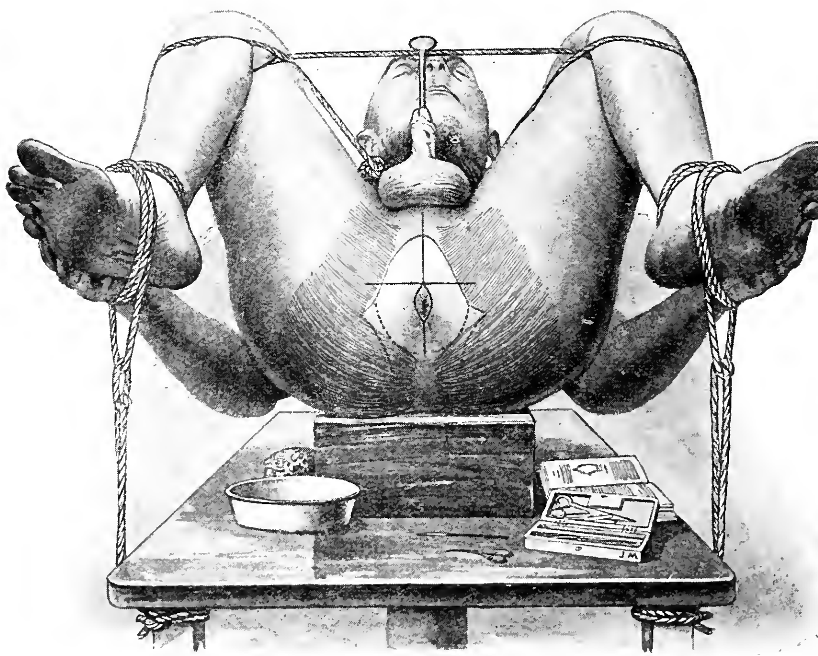

FIG. 75.—Body in Perineal Posture.

In the undissected body, standing in the erect posture, the superficial area of the perineum is very limited. It consists merely of a narrow groove running forwards between the the thighs from the coccyx towards the pubis. In the groove lie the anus, which is the orifice of the anal canal, and the roots of the scrotum and penis, whilst in the middle line a cutaneous ridge called the *median raphe of the perineum* can be seen. The raphe can be traced from the front of the anus forwards over the scrotum and along the inferior surface

of the penis. It is of special interest because it marks the line along which the inferior wall of the urethra was completed and the two halves of the scrotum fused together. It corresponds in position with the urogenital cleft of the female.

Subdivision of the Space.—It is customary to subdivide the diamond-shaped perineal space into two portions by drawing an imaginary transverse line between the anterior parts of the ischial tuberosities, immediately in front of the anus. Two triangles are thus mapped out. The anterior of the two may be appropriately called the *urogenital triangle*, because the most important objects which it contains are the urethra and the root of the penis; the posterior is distinguished as the *anal triangle*, because it contains the anal canal.

Preparation of the Perineum for Dissection.—After the boundaries of the perineum have been defined, and before the dissection is commenced, a staff must be passed along the urethra into the bladder, the anal canal must be slightly distended and the anal orifice stitched up.

Having obtained a staff, oil it or smear it with vaseline, and hold it in the right hand, stand on the left side of the body and seize the penis with the left hand. Hold the staff at right angles to the long axis of the body, introduce its point into the orifice of the urethra and pass it along the urethra, keeping it in contact with the floor of the canal and guiding it with the fingers of the left hand until it arrives at a point about midway between the root of the scrotum and the anus—the *central point of the perineum*. When the point of the staff has reached the central point of the perineum it has passed through the third or penile portion of the urethra. It has now to be passed through the second or membranous part and the first or prostatic part. In order to make it traverse those parts successfully the following steps must be taken: (1) Rotate the staff through quarter of a circle, carrying the handle across the lower part of the abdomen until it lies in the median plane of the body. (2) Steady the point of the staff with a finger of the left hand and with the right hand carry the handle of the staff downwards towards the perineum. If the manœuvre is successful the point of the staff will rise slightly and will pass through the membranous and prostatic parts of the urethra into the

bladder. No force must be used. If any difficulty is experienced, and the point of the staff will not enter the membranous urethra, introduce the index finger of the left hand into the anal canal and again endeavour to guide the point of the staff in the proper direction. It is possible that stricture of the urethra due to disease may prevent the passage of the staff. In that case the dissectors should seek an opportunity of passing the staff in a more satisfactory

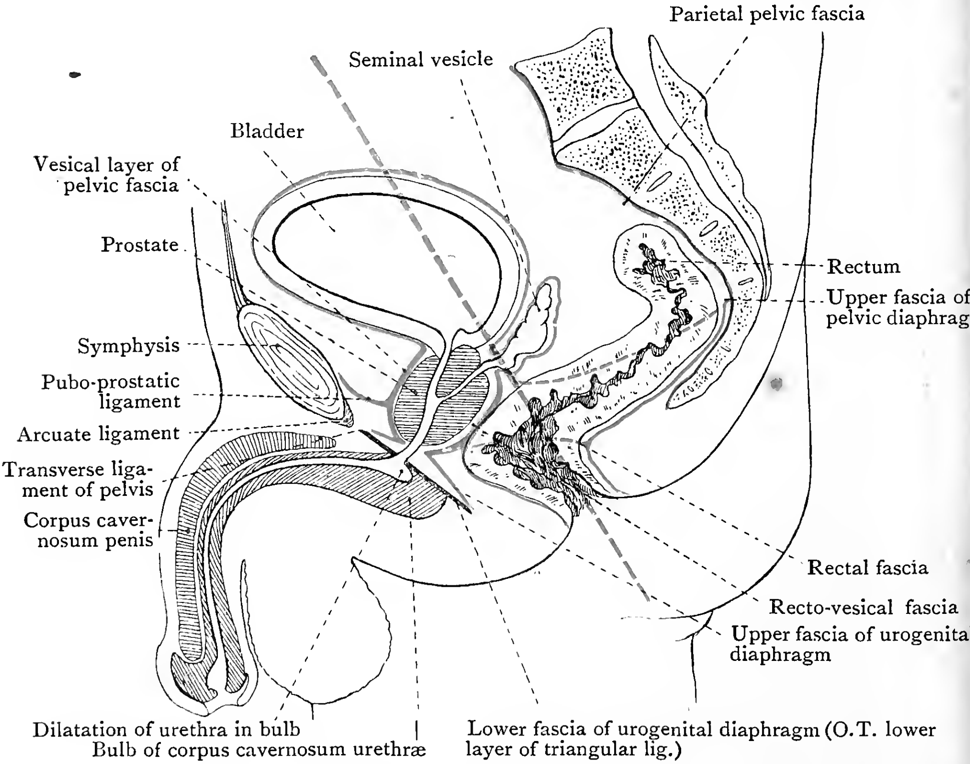

FIG. 76.—Diagram of Urinary Bladder and Urethra.

body. The dissectors should note that the point of the staff is kept to the floor of the canal as it is passed through the penile part of the urethra, because there are depressions in the roof in which it might catch; and that, because there is a depression in the floor of the penile part of the canal, immediately in front of the termination of the membranous part, the tip of the staff must be raised as it is passed from the penile into the membranous part.

When the staff has been passed note that it can be felt

through the skin quite easily, as far back as the central point of the perineum, but no further. Now pass a finger through the anus into the anal canal and note that the staff, as it lies in the membranous part of the urethra, is again quite easily felt; but, at a higher level, as it passes through the prostatic part of the urethra, it is less distinctly felt because it is covered by the posterior part of the prostate.

After the staff has been successfully passed and its surroundings have been investigated with the finger, stitch the most dependent part of the scrotum to the prepuce of the penis, then drag both penis and scrotum forwards on the staff and tie them in position. Next tie the handle of the staff to the cord which passes between the flexed knee-joints of the subject. Lastly introduce a *little* tow, steeped in preservative fluid, into the anal canal and stitch up the orifice of the anus.

***Dissection.*—Reflection of Skin.—Two incisions are required (Fig. 75):—(1) a transverse incision along the line which separates the *anal* from the *urogenital* triangle—*i.e.* in front of the ischial tuberosities; (2) an incision at right angles to the first, in the line of the median raphe. The second incision should begin well forwards on the scrotum and be continued back a little beyond the point of the coccyx. The knife should be carried round the anus so as to encircle it.**

The four triangular flaps which are marked out should now be reflected. Commence the reflection of each flap at its apex. Some difficulty will be experienced in raising the posterior flaps. It is due to the presence of a number of fasciculi of involuntary muscle which radiate outwards from the anus. They form collectively the *corrugator cutis ani*. When the skin has been reflected the *superficial fascia* and the *external sphincter muscle* will be exposed.

Panniculus Adiposus (Superficial Fascia).—The dissectors must examine the superficial fascia carefully. It shows great differences in character and texture in different parts of the perineal area. At the sides of the anal canal in the ischio-rectal fossæ, which lie between the anal canal and the tuberosities of the ischia, it is remarkable for the large quantity of fat it holds in its meshes. That fat is soft and lobulated, and passes upwards upon each side of the anal canal in the form of a pliable and elastic pad. Over the ischial tuberosities the superficial fascia undergoes a striking alteration. In those situations it becomes tough and stringy; dense fibrous septa separate the lobules of fat from one another and connect the skin with the subjacent bone, and it acts as cushions upon which the

tuberosities of the ischia rest when the body is in the sitting posture. Intervening between the fascia and each tuberosity there is a bursa, which may be displayed by an incision carried through the fascia to the bone. Not uncommonly the cavity of the bursa is divided into many loculi by intersecting fibrous septa.

In the anterior part of the perineal region, that is in the urogenital area, another change in the character of the superficial fascia becomes manifest. The farther forwards it is traced the scarcer becomes the fat which it contains in its meshes. In the scrotum the fat entirely disappears and gives place to a thin layer of involuntary muscular fibres, which constitute the *dartos muscle.* They are recognised by their ruddy colour. The rugosity of the scrotal integument is caused by their contraction.

Over the urogenital triangle also the superficial fascia can be shown to consist of two very definite layers. The *superficial layer* is fatty and is not confined to that part of the perineal region. In fact, it is simply a portion of the general fatty covering of the body. Posteriorly, it is continuous with the plugs of fat which fill up the ischio-rectal fossæ; on each side, it leaves the perineum and becomes continuous with the fatty tissue on the medial aspects of the thighs. The *deep layer* is of an altogether different nature. It is a dense membranaceous stratum spread over the urogenital triangle, and it is devoid of fat. It is called the *fascia of Colles.*

The fascia of Colles has very definite attachments and connections. On each side it is attached to the rami of the pubis and ischium. Posteriorly it turns round the two superficial transverse perineal muscles, which extend from the rami of the ischia to the central point of the perineum (Fig. 77), and then blends with the base of the fascia of the urogenital diaphragm, which fills in the urogenital part of the outlet of the pelvis on a deeper plane than that occupied by the fascia of Colles. Towards the front of the perineum the fascia of Colles is continuous with the dartos tissue of the scrotum, and that in its turn is continuous more anteriorly with the fascia of Scarpa, which is the deep layer of the superficial fascia of the abdomen. Laterally both the fascia of Colles and the fascia of the urogenital diaphragm are attached to the rami of the pubis and ischium, and the attachment of the fascia of Colles is prolonged upwards, as it

becomes continuous with the fascia of Scarpa, along the front of the symphysis pubis on each side. In the anterior

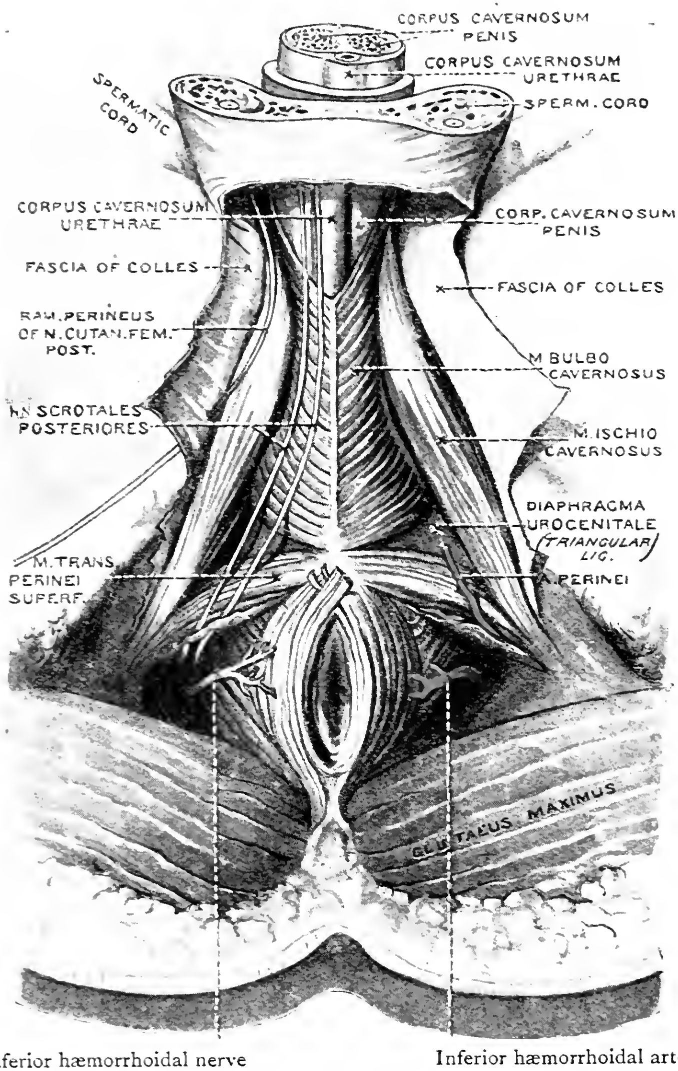

FIG. 77.—Dissection of the Perineum. The Scrotum and the Penis have been cut transversely across and removed.

part of the perineum, therefore, a definite pouch, called the *superficial pouch of the perineum*, is formed. It is bounded *superficially* by the fascia of Colles, *deeply* by the inferior fascia of the urogenital diaphragm, laterally by the attach-

ment of both to the sides of the pubic arch. It is closed *posteriorly* by the fusion of the fascia of Colles with the base of the fasciæ of the urogenital diaphragm, but it is open above and in front, across the front of the symphysis pubis, where its cavity is continuous with the areolar tissue-filled interval between the superficial and the deep fascia of the anterior wall of the abdomen. Within the pouch certain important parts are placed—viz., the superficial perineal muscles, the perineal vessels and the scrotal nerves, the long perineal branch of the posterior cutaneous nerve of the thigh, the bulb of the urethra, the crura of the penis, and the termination of the internal pudendal artery. The pouch is partially divided into right and left halves by a median septum, which dips from the fascia of Colles to the inferior surface of the bulb of the urethra. The septum is very perfect posteriorly, but it becomes incomplete towards the scrotum. Anteriorly, the fascia of Colles passes over the scrotum, penis, and spermatic cords, to the anterior aspect of the abdomen, where it becomes continuous with the fascia of Scarpa.

It follows, from what has already been stated, that if the posterior part of the penile portion of the urethra is injured and urine escapes from it, to one or other side of the median plane, it will first distend the corresponding half of the posterior part of the superficial pouch, next, having reached the limit of the septum, it will distend the opposite half. Then because it cannot escape either posteriorly or laterally on account of the attachments of the fasciæ, it will push its way forwards and upwards into the areolar tissue between the superficial and deep fascia of the abdominal wall, and it may ascend as far as the thorax unless exit is made for it by free incisions, through the skin and superficial fascia, into the pouch. The extravasated urine which has reached the wall of the abdomen cannot descend into the thighs because of the attachment of Scarpa's fascia to the fascia lata near the inguinal ligaments.

Dissection.—The student can verify the above-mentioned facts in two ways, viz.—(1) by inflating the pouch with air, and (2) by dissection. Make a longitudinal incision, large enough to admit the nozzle of the bellows (or, better still, an injection pipe fitted to a bicycle-pump), into the superficial fascia, towards the posterior part of the pouch and a little to one side of the middle line. The cut must be carried through the fascia until the fibres of the superficial perineal muscles are exposed. Introduce the

nozzle of the bellows, or injection pipe, through the incision and compress the margins of the opening round it, then force air into the pouch. The air which is introduced first will fill one side of the pouch, then it will pass forwards to the scrotum, where the septum is incomplete, and will force its way across the median plane to the opposite side. Afterwards, as more air is forced in, it will pass forwards to the abdomen. The pouch is thus rendered prominent and the attachments of the fascia of Colles become evident. The air cannot pass into the anal triangle owing to the union of the fascia of Colles with the base of the fascia of the urogenital diaphragm ; it cannot pass down the medial aspect of the thighs, on account of the attachment of the fasciæ to the sides of the pubic arch ; it can only force its way forwards under the superficial fascia and dartos muscle of the scrotum, and thence on to the penis and the anterior aspect of the abdomen. By the means suggested the dissector will obtain a very striking view of the course which would be taken by urine escaping from a rupture in the urethra below the urogenital diaphragm.

The attachments of the fascia of Colles are so important that the student should test them by dissection also. To do that it is necessary to make two incisions through the superficial fascia. Enter the knife in the middle line at the root of the scrotum, and carry it backwards and laterally to the tuber ischii on each side of the body. A central Λ-shaped flap and two collateral flaps of fascia are thus marked out. When the central portion is raised and turned backwards, the septum of the pouch is brought into view, and the attachment of the fascia to the base of the urogenital diaphragm is demonstrated. When the collateral flaps are turned aside each will be seen to be firmly fixed to the border of the pubic arch. As this dissection is made the utmost care is demanded on the part of the dissector. In the areolar tissue immediately subjacent to the superficial fascia are the *superficial perineal vessels* and *scrotal nerves*, which are certain to be injured, or perhaps even reflected with the fascia, unless the greatest caution is exercised.

Anal Triangle.

The dissection of the anal portion of the perineal space will disclose the following parts :—

1. The external sphincter ani muscle.
2. The anal canal, covered by the levator ani muscle and the inferior fascia of the pelvic diaphragm.
3. The obturator fascia.
4. The lower border of the glutæus maximus muscle and the ligamentum sacro-tuberosum (O.T. great sacro-sciatic).
5. The ano-coccygeal body.
6. The inferior hæmorrhoidal vessels and nerve.
7. The perineal artery.
8. The perineal branch of the fourth sacral nerve.
9. The perineal nerve and its branches.
10. The perforating cutaneous branch of the second and third sacral nerves.

Dissection.—Clean the sphincter ani externus. Make an incision through the fascia which covers the muscle, from the tip of the coccyx to the anus, carry it forwards round the sides of the stitches which were used to close the anus, and then onwards to the central point of the perineum in the median plane. Reflect the fascia to each side and, as the borders of the muscle are defined, secure the branches of the inferior hæmorrhoidal nerve and artery and the perineal branch of the fourth sacral nerve, which supply the muscle.

M. Sphincter Ani Externus.—When the external sphincter muscle of the anus is cleaned it will be seen to consist of a thick ring of muscular fibres which surround the orifice of the anal canal. *Posteriorly*, it is attached, by a pointed tendon, to the tip and posterior surface of the terminal part of the coccyx; *anteriorly*, it blends with other perineal muscles in the central point of the perineum. As the fibres pass between the two points of attachment, they encircle the anal orifice and form a true sphincter muscle. Some of the superficial fibres, both in front of and behind the anal opening, are directly attached to the skin. (It draws its nervous supply from two sources, viz., the *fourth sacral nerve* and the *inferior hæmorrhoidal nerve.*)

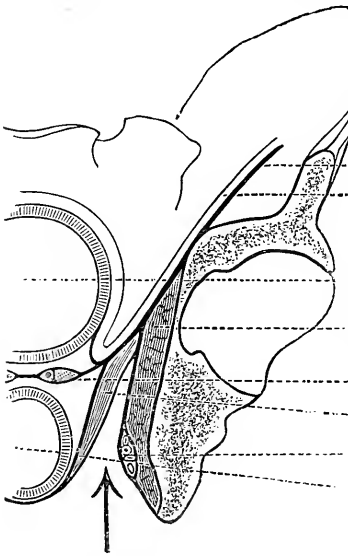

FIG. 78.—Diagram. The arrow is directed upwards into the ischio-rectal fossa. The parietal pelvic fascia is seen upon the medial surface of the obturator internus. Observe also the inferior fascia of the pelvic diaphragm clothing the lateral surface of the levator ani and the rectal fascia upon its medial surface.

Contents of the Anal Triangle.—The next step in the dissection of the perineum is the display of the *ischio-rectal fossæ* and their contents, but before the dissection is commenced the dissectors should have a general idea of the position and contents of the fossæ.

Passing through the middle of the anal triangle of the perineum is the anal canal, which terminates at the anus.

It is covered on each side by the levatores ani and coccygei muscles and their fasciæ; but the canal and the muscles which cover it occupy only the middle part of the triangle, and on each side between the muscles covering the canal and the lateral boundary of the triangle lies an *ischio-rectal fossa.* The fossa is bounded, *medially* by the levator ani and the coccygeus, *laterally* by the ischium covered by the obturator internus and the obturator fascia, *posteriorly* by the inferior borders of the glutæus maximus and the sacro-tuberous ligament, and *anteriorly* by the base of the fascia of the urogenital diaphragm blended with the posterior border of the fascia of Colles. Each ischio-rectal fossa is filled with a pad of soft elastic fat in which lie the inferior hæmorrhoidal vessels, accompanied by the inferior hæmorrhoidal nerve, the perineal branch of the fourth sacral nerve, portions of the superficial and deep branches of the perineal nerve and the accompanying rami of the perineal branch of the pudendal artery. All the structures mentioned must now be displayed.

Dissection.—Begin, on each side, by exposing the inferior margin of the glutæus maximus muscle, which forms one of the posterior boundaries of the fossa. Take a point a short distance to the lateral side of the ischial tuberosity and another in the median plane about an inch above the tip of the coccyx, and cut boldly down through the superficial fascia, in a line between those points, until the deep fascia covering the fleshy fibres becomes visible. Winding round the margin of the muscle, so as to gain its superficial aspect, there are a few small arteries and nerves. The arteries are derived from the *inferior hæmorrhoidal vessels*, or from the *inferior gluteal artery*, whilst the nerves are the *perforating cutaneous branch* from the second and third sacral nerves and some offsets from the *posterior cutaneous nerve of the thigh.* All are destined for the supply of the skin over the inferior part of the gluteal region. The perforating cutaneous nerve turns round the margin of the glutæus maximus near the coccyx, whilst the gluteal branches from the posterior cutaneous nerve of the thigh appear on the lateral side of the tuber ischiadicum. When the vessels and nerves mentioned have been secured, clean the lower border of the glutæus maximus, then push the fat in the fossa in front of it forwards, pull the muscle backwards and expose and clean the lower border of the sacro-tuberous ligament, which lies under cover of the muscle. After the margin of the sacro-tuberous ligament has been defined, detach the fat from the lateral wall of the fossa, partly with the aid of the blade and partly with the aid of the handle of the scalpel, and push it forwards and medially, but be careful not to injure any vessels or nerves. When the fat has been detached from the posterior and lateral walls of the fossæ carry the knife obliquely forwards and medially in the fat, from the angle between the glutæus maximus and the ischial tuberosity towards

the anus, and secure the inferior hæmorrhoidal vessels and nerves. Follow them to their termination in the medial wall, in the sphincter ani externus and the levator ani muscles. Next turn to the anterior part of the lateral wall of the fossa, dissect carefully in the angle between it and the base of the urogenital diaphragm and find the lateral and medial posterior scrotal branches of the superficial division of the perineal nerve (posterior labial nerves of female), and the scrotal branches (labial in female) of the perineal artery which accompany the nerves. Find also the deep division of the perineal nerve and the transverse perineal artery. The posterior scrotal nerves and arteries (posterior labial in female) pierce the fascia of Colles as it blends with the base of the fascia of the urogenital diaphragm, the deep branch of the perineal nerve pierces the base of the fascia of the urogenital diaphragm, and the transverse perineal artery runs along the posterior border of the diaphragm.

The perineal branch of the fourth sacral nerve must be sought about a finger's breadth from the tip of the coccyx. It pierces the coccygeus muscle and runs downwards and forwards to the external sphincter ani. After the nerves and vessels have been found and cleaned the remains of the fat must be removed from the fossa and its boundaries and contents must be studied.

Ischio-rectal Fossæ.—There are two ischio-rectal fossæ, right and left. *Position.*—Each fossa lies in the anal triangle of the perineum between the anal canal of the rectum and the ischium, but neither the anal canal nor the ischium enters directly into the formation of the walls of the fossa, for both are separated from the cavity of the space by fascial and muscular layers.

The anal canal is covered by the superior fascia of the pelvic diaphragm (O.T. rectal layer of the visceral portion of the pelvic fascia), the levator ani and the inferior fascia of the pelvic diaphragm (O.T. anal fascia)—in that order from the medial to the lateral side. The medial aspect of the ischium is separated from the cavity of the fossa by the obturator internus muscle and by the obturator fascia, which covers the muscle and binds it to the bone.

Shape.—Each ischio-rectal fossa is pyramidal in shape. The apex is above, towards the cavity of the pelvis, the base below, at the integument of the perineum. The medial wall slopes upwards and laterally. The lateral wall ascends vertically from the tuber ischii and meets the medial wall at the apex of the fossa.

Boundaries.—Speaking strictly, the *medial wall* of the fossa is formed by the inferior fascia of the pelvic diaphragm which covers the lower surfaces of the levator ani and the coccygeus muscles. The *lateral wall* is formed by the

obturator fascia, which clothes the medial surface of the obturator internus. At the *apex* or *roof* the obturator fascia blends with the inferior fascia of the pelvic diaphragm. The *anterior boundary* is the base of the fascia of the urogenital diaphragm and the transversus perinei muscle which runs along its superficial aspect. The *posterior boundary* is formed by the inferior borders of the sacro-tuberous ligament and the glutæus maximus muscle. The *inferior boundary* is the tough integument of the posterior part of the perineum.

The fossa is widest and deepest posteriorly, and narrowest and most shallow in front, where it is prolonged forwards, above the base of the fascia of the urogenital diaphragm.

In its lateral wall, in a canal in the obturator fascia,[1] 35-40 mm. above the lower margin of the ischial tuberosity, lie the internal pudendal artery and its venæ comites with the perineal nerve below them and the dorsal nerve of the penis above them. The inferior hæmorrhoidal branch of the pudendal nerve and the accompanying inferior hæmorrhoidal branch of the internal pudendal artery pierce the fascia of the lateral wall posteriorly, and the superficial and deep terminal branches of the perineal branch of the pudendal nerve and the perineal and transverse perineal branches of the internal pudendal artery pierce it anteriorly. The perineal branch of the fourth sacral nerve pierces the lower part of the coccygeus muscle in the medial wall.

The contents of the fossa are:—(1) An elastic pad of fat, which fills the cavity. (2) The inferior hæmorrhoidal vessels and nerves which traverse the fat on their way from the postero-lateral angle to the medial wall of the fossa. (3) Portions of the posterior scrotal (labial) branches of the superficial division of the perineal nerve. (4) The deep division of the perineal nerve. (5) The perineal and transverse perineal arteries, in the anterior angle. (6) The perineal branch of the fourth sacral nerve is at the postero-medial angle. (7) Turning round the inferior border of the glutæus maximus, between the coccyx and the ischium, the perforating cutaneous branch from the second and third sacral nerves.

The fat which fills the fossa acts as an elastic pad which allows the anal passage to expand as the fæces are expelled through it, and assists it in closing the canal after the fæces have passed.

[1] O.T. Alcock's canal.

The weakest wall of the fossa is the medial wall, which is formed by muscles and fasciæ only; therefore if an abscess forms in the fossa the contents of the abscess are apt to force their way into the anal canal, unless an exit is made for them through the skin of the base of the fossa.

Arteria Pudenda Interna et Nervus Pudendus.—If the dissector passes his index finger upwards and downwards over the obturator fascia, which forms the lateral wall of the ischio-rectal fossa, he will feel a ridge which runs from behind forwards. It lies about 38 mm. (one and a half inches) above the inferior border of the ischial tuberosity, and is caused by the internal pudendal artery and the accompanying perineal nerve and the dorsal nerve of the penis, which are branches of the pudendal nerve. At the posterior end of the ridge the inferior hæmorrhoidal artery and nerve will be found piercing the wall of the fascial canal and passing into the fossa, and at the anterior end the superficial and deep terminal branches of the perineal nerve and the perineal and transverse perineal branches of the internal pudendal artery pierce the medial wall of the canal as they enter the fossa. For the present the dissector must be satisfied with palpating the structures which lie in the canal. To expose them it would be necessary to divide the obturator fascia, and that must be kept intact until the pelvic fascia can be studied as a whole. In the meantime, however, the dissector should recall to mind the fact that he displayed the pudendal nerve and the internal pudendal artery during the dissection of the buttock, when he cleaned the structures exposed by the reflection of the glutæus maximus (see Vol. I. p. 287). There they rested on the spine of the ischium or the sacro-spinous ligament and disappeared into the perineum through the lesser sciatic foramen. Now they are met with again as they lie in a canal in the obturator fascia in the lateral wall of the ischio-rectal fossa, where the nerve divides into the inferior hæmorrhoidal nerve, the perineal nerve, and the dorsal nerve of the penis, and the artery gives off inferior hæmorrhoidal, perineal, and transverse perineal branches. At the anterior end of the ischio-rectal fossa the canal in the obturator fascia opens into the space between the two layers of fascia of the urogenital diaphragm, and the internal pudendal artery and the dorsal nerve of the penis pass into that space, where they will be dissected later.

Arteriæ Hæmorrhoidales Inferiores.—The inferior hæmorrhoidal arteries, usually two or three in number, are branches of the internal pudendal. They pierce the medial wall of the canal in the obturator fascia, and pass medially, through the fat of the ischio-rectal fossa, to supply the anal canal and the muscles in connection with it, as well as the skin around the anus. Around the anal canal they anastomose with the corresponding arteries of the opposite side, and with branches from the middle and superior hæmorrhoidal arteries. They also send a few twigs round the lower border of the glutæus maximus, in company with the perforating cutaneous nerve, to supply the skin of the lower part of the buttock.

N. Hæmorrhoidalis Inferior.—The inferior hæmorrhoidal nerve accompanies the vessels of the same name. It may proceed directly from the sacral plexus, but more frequently it is a branch of the pudendal nerve. It perforates the medial wall of the canal in the obturator fascia, enters the ischio-rectal fossa, and then it breaks up into muscular, cutaneous, and communicating branches. The *muscular twigs* supply the external sphincter ani; the *cutaneous offsets* are given to the skin which surrounds the anus; while the *communicating filaments* pass forwards to join the scrotal nerves and the long perineal branch of the posterior cutaneous nerve of the thigh.

Perineal Branch of Fourth Sacral Nerve.—The perineal branch of the fourth sacral nerve is small. It enters the ischio-rectal fossa by piercing the coccygeus muscle at the side of the coccyx. It is distributed to the skin between the anus and coccyx, and to the external sphincter ani muscle.

The perineal artery and the superficial and deep branch of the perineal nerve, which were found in the anterior angle of the fossa close to the lateral wall, will be traced forwards, in the next stage of the dissection, in the urogenital triangle.

Ano-coccygeal Body.—An indefinite mass of muscular and fibrous tissue which lies between the tip of the coccyx and the anus receives the name of *ano-coccygeal body*. It is seen best in sections through the pelvis, and it requires notice on account of the support which it gives to the lower part of the rectum and the anal canal. (The muscular tissue which enters into its constitution belongs to the levator ani and the external and internal sphincter muscles) (Symington).

Urogenital Triangle.

The superficial fascia of the urogenital triangle has already been studied (p. 151). The following structures which lie in the area still require to be dissected:—

1. The posterior scrotal vessels and nerves.
2. The long perineal branch of the posterior cutaneous nerve of the thigh.
3. The root of the penis. {The bulb of the urethra and the crura.
4. The superficial perineal muscles.
   - *a.* Superficial transverse perineal muscle.
   - *b.* Bulbo-cavernosus muscle.
   - *c.* Ischio-cavernosus muscle.
5. Inferior fascia of the urogenital diaphragm.
6. The internal pudendal vessels and their branches and the pudendal nerve and its branches.
7. The deep transverse perineal muscle and the sphincter of the membranous urethra.
8. The bulbo-urethral glands.
9. The membranous portion of the urethra.
10. Superior fascia of the urogenital diaphragm.

Dissection.—Clear away the remains of the fascia of Colles from the urogenital triangle; then clean the perineal artery and follow its terminal scrotal branches to the scrotum. Clean also the posterior scrotal branches of the superficial division of the perineal nerve, and whilst cleaning them find the long perineal branch of the posterior cutaneous nerve of the thigh. It communicates with the posterior scrotal nerves in the perineal pouch. When it is found, trace its terminal branches to the scrotum, and trace its trunk backwards to the point where it enters the superficial pouch of the perineum by piercing the fascia of Colles, about 25 mm. (one inch) anterior to the tuberosity of the ischium. As the nerves are followed three muscles will be more or less displayed:—Along the margin of the pubic arch the ischio-cavernosus; near the median plane the bulbo-cavernosus; and, crossing between their posterior extremities, the superficial transverse perineal muscle.

Superficial Arteries and Nerves.—

Arteries.
1. The perineal artery.
2. The transverse branch of the perineal artery.

Nerves.
1. The posterior scrotal nerves.
2. The long perineal branch of the posterior cutaneous nerve of the thigh.

The *perineal artery*, a branch of the pudendal, pierces first the medial wall of the canal in the obturator fascia, then the base of Colles' fascia, and so it gains the interior of the perineal pouch of fascia. In the pouch it crosses superficial to the transversus perinei muscle, and is continued forwards, in the interval between the bulbo-cavernosus and ischio-

cavernosus muscles, to the scrotum, to the dartos muscle and integument of which it is distributed in the form of numerous long, slender branches, called the *posterior scrotal arteries.* Before it reaches the scrotum, it supplies twigs to the superficial perineal muscles. It is accompanied by the posterior scrotal branches of the perineal nerve.

The *transverse perineal artery* is a small vessel which usually springs from the preceding. It pierces the base of the fascia of Colles, and, gaining the surface of the superficial transverse perineal muscle, proceeds medially to the interval between the rectum and the bulb of the urethra, where it ends by supplying the parts in that locality, and by anastomosing with the corresponding vessel of the opposite side.

The *posterior scrotal nerves* are branches of the perineal division of the pudendal nerve. They appear in the anterior part of the ischio-rectal fossa after piercing the obturator fascia. Then they pierce the base of the fascia of Colles and pass forwards in the superficial pouch to the scrotum.

The *long perineal branch of the posterior cutaneous nerve of the thigh* (O.T. *long pudendal nerve*) pierces the deep fascia of the thigh a short distance in front of the ischial tuberosity, and about an inch and a half to the lateral side of the margin of the pubic arch. As it proceeds forwards it inclines medially, and, piercing the attachment of Colles' fascia to the margin of the pubic arch, it accompanies the other vessels and nerves to the scrotum, the lateral and anterior part of which it supplies.

After the superficial vessels and nerves, which lie in the perineal pouch on each side, have been examined, the dissector must proceed to display the other contents of the superficial pouch, viz.—the three parts of the root of the penis; they are the bulb of the urethra, which lies in the median plane, and the right and left crura of the penis, which are attached to the corresponding borders of the pubic arch; the bulbo-cavernosus muscle which covers the bulb of the urethra, the ischio-cavernosus muscles which cover the crura of the penis, and the superficial transverse muscles of the perineum which lie parallel with the base of the superficial pouch. When those structures have been studied he must seek, on each side, the dorsal nerve of the penis, the terminations of the deep branch of the perineal nerve, and three branches of the internal pudendal artery, viz., the artery of the bulb,

the dorsal artery of the penis, and the deep artery of the penis.

The bulb of the urethra causes the projecting rounded eminence which occupies the median part of the superficial perineal pouch. It is covered by the bulbo-cavernosus muscle. Each crus penis lies along the corresponding lateral margin of the superficial pouch, and it is covered by the ischio-cavernosus muscle. The superficial transverse muscle passes forwards and medially from the posterior end of the crus penis to the central point of the perineum, which lies immediately behind the posterior end of the bulb of the urethra.

Dissection.—Divide the scrotal nerves and the accompanying arteries near their terminal extremities and turn them aside; then, with the handle of the scalpel, enlarge the interval between the bulb of the urethra, covered by the bulbo-cavernosus, medially, the crus of the penis, covered by the ischio-cavernosus, laterally, and the superficial transverse muscle posteriorly. The membrane which forms the deep boundary of the triangular area thus displayed is the inferior fascia of the urogenital diaphragm.

Only the lower part of the diaphragm is obvious at this stage of the dissection, but the dissector must consider the structure and the general positions and relations of the diaphragm before proceeding further with the dissection.

Urogenital Diaphragm.—Only the superficial surface of the inferior fascia of the urogenital diaphragm is as yet exposed, but it is necessary, before the dissection is carried further and the diaphragm is partially destroyed, that the dissectors should have a general knowledge of its various parts, so that they may understand the relations of the diaphragm to the other structures which lie in the anterior part of the perineum. The *urogenital diaphragm* is a strong, triangular partition which stretches across the pubic arch and separates the anterior part of the perineum from the pelvis. It consists of the deep transverse muscle of the perineum, and the sphincter urethræ membranaceæ, enclosed between two layers of fascia, an upper and a lower. The two layers of fascia are blended together anteriorly and posteriorly. They are attached laterally to the margins of the pubic arch, and they enclose between them a space which contains not only the muscular part of the diaphragm but also the membranous portion of the urethra, the bulbo-urethral glands (O.T. Cowper's), the terminal parts of the internal pudendal vessels and some of their branches, and the dorsal nerves of the penis. The blended *anterior* margins of the *inferior fascia of the urogenital*

diaphragm (O.T. superficial layer of the triangular ligament), and *superior fascia of the urogenital diaphragm* (O.T. deep layer of the triangular ligament) form the *transverse ligament of the pelvis*, and their blended *posterior* margins form the base of the urogenital diaphragm.

The space between the two fasciæ of the urogenital diaphragm is spoken of as the deep pouch of the urethral triangle of the perineum, in contradistinction to the superficial pouch which lies between the inferior fascia of the diaphragm and the fascia of Colles and has already been examined.

The deep pouch of the urethral triangle contains the deep transverse muscle of the perineum and the sphincter muscle of the membranous urethra, which constitute the muscular portion of the urogenital diaphragm; the membranous part of the urethra; the bulbo-urethral glands; the internal pudendal arteries; their branches to the bulb of the urethra and their terminal branches—the dorsal arteries of the penis and the profunda arteries of the penis; the terminal branches of the deep division of the perineal nerve and the dorsal nerve of the penis.

The membranous part of the urethra enters the deep pouch by piercing the superior fascia of the urogenital diaphragm and leaves it by piercing the inferior fascia. It is accompanied at its exit by the ducts of the bulbo-urethral glands. Each internal pudendal artery and each dorsal nerve of the penis enters the posterior part of the deep pouch at the anterior end of the canal in the obturator fascia. The terminal branches which the internal pudendal artery gives off in the deep pouch leave the pouch by piercing the inferior fascia of the urogenital diaphragm. The dorsal nerve of the penis accompanies the dorsal artery of the penis, which is one of the terminal branches of the internal pudendal artery.

Dissection.—Follow the constituent parts of the root of the penis forwards until they blend to form the body of the penis. Note (1) that the bulb of the urethra diminishes in size as it passes forwards to the under surface of the body of the penis where it forms the middle part of the corpus cavernosum urethræ, the bulb of the urethra being the posterior part and the glans penis the anterior part of that structure. (2) That immediately below the apex of the pubic arch the crura of the penis blend together on the dorsum of the penis to form the corpus cavernosum penis, which constitutes the large dorsal part of the body of the penis.

After the constituent parts of the root of the penis have been

fully defined, clean, on each side, the ischio-cavernosus muscle which covers the superficial surface of the crus penis. Follow it backwards to its origin from the medial aspect of the posterior portion of the ramus of the ischium. Then clean the superficial transverse muscle, which springs from the same point, and follow it to its insertion into the central point of the perineum. Next clean the bulbo-cavernosus muscle. Note that it springs from the central point of the perineum and from a fibrous raphe on the superficial surface of the bulb of the urethra. Trace its posterior fibres round the sides of the bulb to the superficial surface of the inferior fascia of the urogenital diaphragm to which they are attached. Note (1) that the middle fibres pass round the sides of the corpus cavernosum urethræ and blend with the muscle of the opposite side on its dorsal surface, ventral to the anterior ends of the crura penis. (2) That the anterior fibres pass round the sides of the corpus cavernosum penis and blend with their fellows of the opposite side on the dorsum of the penis. The arrangement of the fibres shows quite clearly that when the muscles of the two sides act together they must compress the bulb of the urethra, the corpus cavernosum urethræ and the corpus cavernosum penis.

After the superficial perineal muscles have been examined divide the superficial transverse muscle, turn it aside, and attempt to find the terminal twigs of the deep branch of the perineal nerve which pass deep to the superficial transverse muscle and are distributed to that muscle, to the bulbo- and ischio-cavernosus muscles, and to the bulb of the urethra. Next detach the crus penis from the rami of the pubis and ischium, and the superficial surface of the inferior fascia of the urogenital diaphragm. Commence at its posterior end, pass carefully forwards until the profunda artery of the penis is found piercing the inferior fascia of the urogenital diaphragm and entering the crus. Clean that artery for a short distance, and secure the dorsal artery and dorsal nerve of the penis which pierce the inferior fascia of the urogenital diaphragm close to the profunda artery. Then turn to the bulb of the urethra. Detach the posterior end of the bulb from the central point of the perineum, and turn it carefully forwards until the urethra is found entering it in the median plane, and an artery on each side. The arteries are the arteries to the bulb, from the internal pudendal arteries. Do not injure either the arteries or the urethra, but clean the superficial surface of the inferior fascia of the urogenital diaphragm, and then proceed to the study of the structures exposed.

Superficial Perineal Muscles.—Under this heading are included not only the bulbo-cavernosus and ischio-cavernosus muscles, but also the superficial transverse perineal muscles. The superficial perineal muscles have been seen to lie within the pouch formed by the fascia of Colles and the inferior fascia of the urogenital diaphragm. Each muscle is invested by its own delicate layer of deep fascia.

M. Transversus Perinei Superficialis.—The superficial transverse perineal muscle is a narrow slip of muscular fibres

which arises from the medial aspect of the ramus of the ischium close to the tuberosity. It passes medially and unites with the corresponding muscle of the opposite side in the central point of the perineum.

The *central point of the perineum* is a tendinous septum, situated in the middle line of the body, close to the posterior end of the bulb and a short distance in front of the anus. Towards it a number of the perineal muscles converge to obtain attachment. *On each side*, it gives attachment to a superficial transverse perineal muscle; *posteriorly*, to the sphincter ani; *anteriorly*, to the posterior fibres of the bulbo-cavernosus; whilst *superiorly*, the anterior fibres of the levator ani descend to reach it.

M. Bulbo-cavernosus (O.T. **Ejaculator Urinæ**).—The bulbo-cavernosus muscle is spread over the bulb and posterior part of the corpus cavernosum urethræ. It is composed of two symmetrical halves, and its fibres take origin from the central point of the perineum and from a fibrous median raphe which is prolonged forwards between the two halves of the muscle. The insertion differs according to the point at which the muscle is examined. The *posterior fibres* are attached to the superficial aspect of the inferior fascia of the urogenital diaphragm; the *middle fibres*, constituting the greater part of the muscle, sweep around the corpus cavernosum urethræ, so as to invest it completely, and are inserted into an aponeurosis upon the superior surface of that portion of the penis; lastly, the *anterior fibres* form two long narrow muscular bands which diverge from each other like the limbs of the letter V. They pass forwards, over the sides of the corpus cavernosum penis, and are inserted into an aponeurosis on the dorsum of the penis. Thus the *posterior fibres* partially embrace the bulb; the *middle fibres* embrace the corpus cavernosum urethræ; whilst the *anterior fibres* embrace the body of the penis. The bulbo-cavernosus supports the urethra during micturition, and by its contraction it ejects the last drops of urine or semen from the passage.

M. Ischio-cavernosus (O.T. **Erector Penis**).—The ischio-cavernosus lies upon the crus penis. It arises by fleshy fibres from the medial aspect of the ramus of the ischium close to the tuberosity, and is inserted, by an aponeurotic expansion, into the lower and lateral surface of the anterior portion of the crus.

Radix Penis.—The root of the penis consists of a middle part, the bulb of the urethra, and right and left lateral parts, the crura of the penis.

The *crura penis* are the posterior segments of the corpus cavernosum penis, which forms the dorsal part of the body of the penis. Each is attached to the rami of the pubis and ischium of the corresponding side, and to the adjacent part of the inferior surface of the inferior fascia of the urogenital diaphragm. Its superficial surface is covered by and gives attachment to the corresponding ischio-cavernosus muscle. The profunda artery of the penis enters the anterior part of its deep surface, and the corresponding vein issues from it at the same point to form one of the venæ comites of the internal pudendal artery.

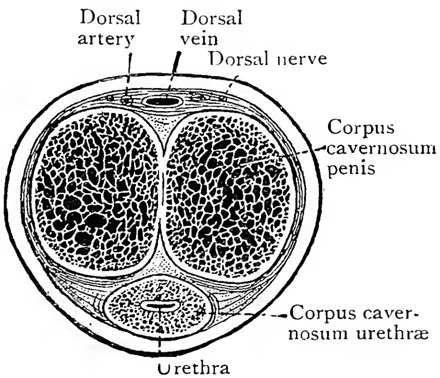

Fig. 79.—Transverse section through the body of the Penis.

The *bulb of the urethra* is the posterior expanded part of the corpus cavernosum urethræ, which lies on the lower surface of the body of the penis, partly embedded in a groove on the inferior aspect of the corpus cavernosum penis. At the anterior end of the penis the corpus cavernosum urethræ enlarges into a cap-like expansion, the glans penis, which covers the anterior end of the corpus cavernosum penis, and posteriorly, in the superficial pouch of the urethral triangle it separates from the corpus cavernosum penis and again enlarges to form the bulb of the urethra which is the middle segment of the root of the penis (Figs. 80, 81, 82).

The *bulb of the urethra* is attached to the inferior surface of the inferior fascia of the urogenital diaphragm by fibrous tissue and by the bulbo-cavernosus muscles. Immediately anterior to its posterior end, the urethra, the ducts of the bulbo-urethral glands, and the arteries to the bulb, one from each internal pudendal artery, enter it, after they have pierced the inferior fascia of the urogenital diaphragm. Occasionally the posterior end of the bulb is divided by a median notch which indicates its bilateral origin.

Nervus Perinei.—The perineal nerve is one of the terminal branches of the pudendal nerve. It arises in the posterior part of the canal in the obturator fascia on the lateral wall of the ischio-rectal fossa, and runs forwards, in the canal, below the internal pudendal artery. At a varying point from its commencement it divides into superficial and deep branches. (The superficial branches are the scrotal nerves.) They pierce the wall of the fascial canal and enter the

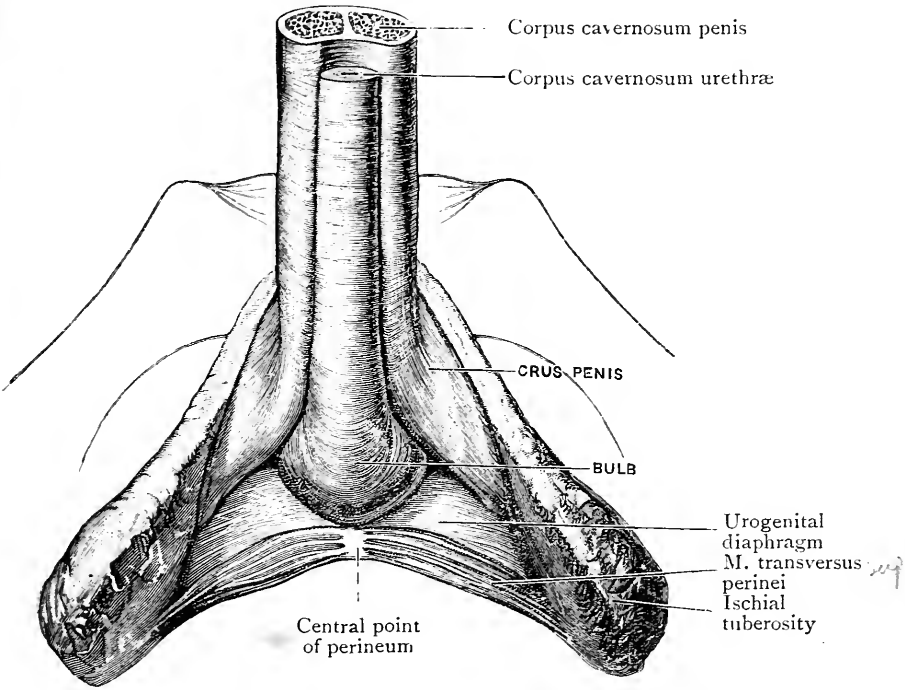

FIG. 80.—The Root of the Penis and the Fascia inferior of the Urogenital Diaphragm (O.T. triangular ligament) (Formalin specimen).

anterior part of the ischio-rectal fossa, then they pierce the base of the fascia of Colles and enter the superficial pouch of the urogenital triangle, there they cross superficial to the superficial transverse muscle of the perineum, and are distributed to the skin of the anterior part of the perineum and to the skin of the scrotum.

(The deep branch supplies twigs to the anterior part of the levator ani and the external sphincter ani, then pierces the base of the inferior fascia of the urogenital diaphragm, and enters the superficial pouch, where it supplies the super-

ficial transverse muscle, the bulbo-cavernosus, and the ischio-cavernosus, and it gives a branch to the bulb of the urethra. Some of its branches enter the deep pouch to supply the deep transverse muscle and the sphincter of the membranous urethra.

Inferior Fascia of the Urogenital Diaphragm.—An examination of the inferior fascia of the urogenital diaphragm,

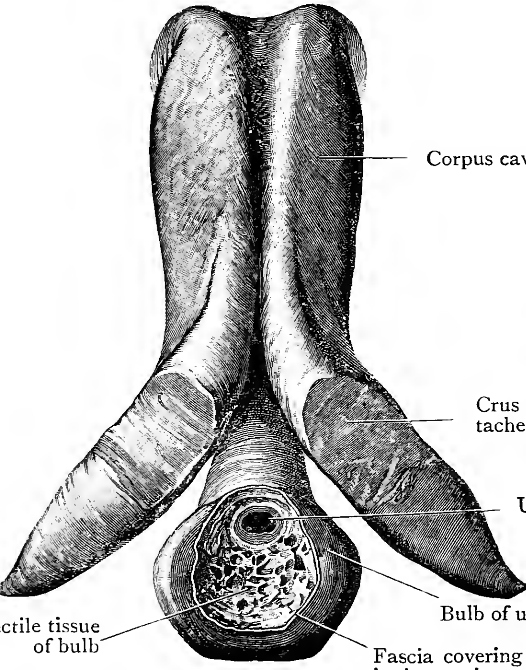

FIG. 81.—Dorsal or attached aspect of the Penis. The specimen was hardened by formalin injection and removed from the pubic arch and the urogenital diaphragm.

which has been considerably exposed by the reflection of the crura of the penis and the turning forward of the posterior part of the bulb of the urethra (see p. 166), will show that it is a strong fibrous membrane which stretches across the pubic arch. It may be regarded as lying in the same morphological plane as the bony and ligamentous wall of the pelvis, and as completing the pelvic wall in front, much in the same manner as the obturator membrane fills up the obturator foramen.

Upon each side the inferior fascia of the urogenital

diaphragm is attached to the medial surfaces of the rami of the pubis and ischium. Its base has already been seen to blend, along the posterior border of the superficial transversus perinei muscles, with the fascia of Colles. In addition to that attachment, however, a careful dissection, in a good subject, will show that the central part of the base projects backwards in the form of a short process which joins the central point of the perineum. Near the symphysis pubis the anterior margin, fused with the anterior margin of the superior fascia of the diaphragm, forms the transverse ligament of the pelvis. Between the anterior border of the transverse ligament and the arcuate ligament, which covers the inferior aspect of the symphysis pubis, an oval gap is left for the passage of the dorsal vein of the penis.

In the erect posture of the body the superficial surface of the urogenital diaphragm looks downwards and forwards, whilst its deep surface looks upwards and backwards towards the cavity of the pelvis. In close contact with its inferior fascia are the parts which constitute the root of the penis, viz., the bulb and the two crura, and the muscles which are associated with them, and also the superficial transversus perinei muscle on each side. The structures which lie between its two fasciæ will be studied after the inferior fascia is reflected.

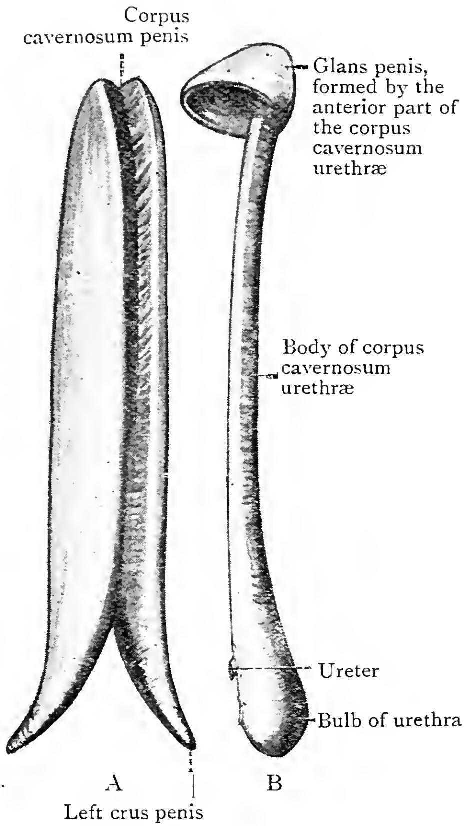

FIG. 82.—Component Parts of Penis.

A. Corpus cavernosum penis and the crura penis, seen from the right and below. Showing the groove for the corpus cavernosum urethræ.

B. Corpus cavernosum urethræ.

The inferior fascia of the urogenital diaphragm is not an unbroken, continuous layer. It is pierced—(1) by the urethra; (2) by the internal pudendal arteries or their terminal branches; (3) by the dorsal nerves of the penis; (4) by the arteries to the bulb; (5) and lastly, at its base, where it blends with the superficial fascia, by the deep branch of the perineal nerve. The *aperture for the urethra* is situated in the middle line, 25 mm. (one inch) below the

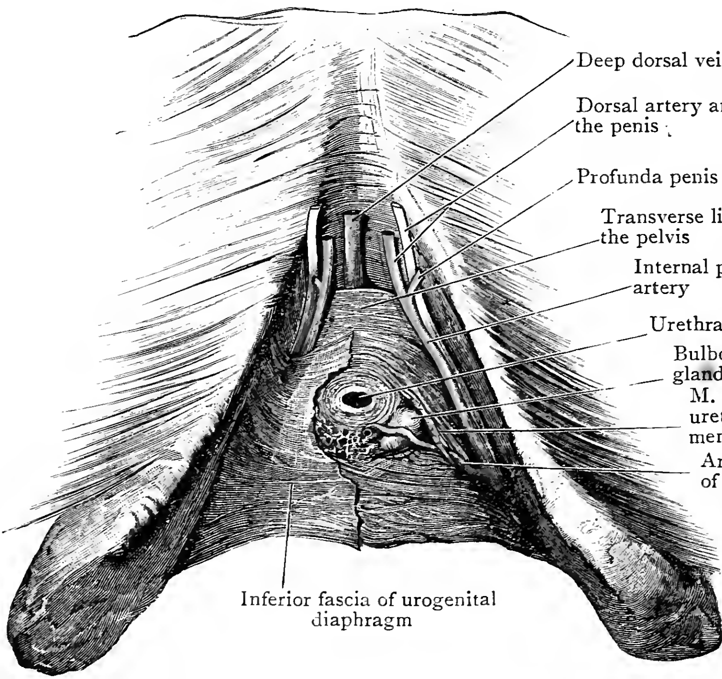

FIG. 83.—Deep dissection of the Perineum. The penis has been removed, the urethra cut across, and the inferior fascia of the urogenital diaphragm removed on the left side.

symphysis pubis. It is not a clean-cut hole with sharp edges. The margins of the opening, which are separated by a considerable interval from the circumference of the urethra, are prolonged over the bulb of the urethra so as to form for it a fibrous capsule. As soon as the urethra gains the superficial aspect of the fascia it sinks into the bulb, and is carried forwards, through the entire length of the corpus cavernosum urethræ, to its external opening on the glans penis. On each side of the urethral aperture there is a small opening in the fascia which gives passage to the

corresponding *artery to the bulb.* Half an inch farther forwards the *dorsal nerve of the penis* and the *internal pudendal artery* or its two terminal branches pierce the fascia on each side, close to the margin of the pubic arch, and under cover of the corresponding crus penis.

The term "*inferior fascia*" of the urogenital diaphragm which is applied to this membrane, implies that there is a deeper fascia to be studied in connection with it. But whilst the two fasciæ are very intimately connected, they must be looked upon as being distinct structures. The inferior fascia of the urogenital diaphragm is in the same morphological plane as the bony wall of the pelvis and the obturator membrane, and, in fact, completes the pelvic wall in front. The *superior fascia of the urogenital diaphragm* is merely the parietal layer of the pelvic fascia carried round to the front of the pelvis. Consequently the connections of the latter layer can be examined very much better in conjunction with the pelvic fascia. It should now be noted—(1) that the two fasciæ enclose the urogenital diaphragm; (2) that the anterior and posterior margins of the two layers are blended together; (3) that the interval between the two is closed laterally by the attachment of both layers to the margins of the pubic arch; and (4) that the space between the two layers contains:—

1. The membranous portion of the urethra and its sphincter muscle.
2. The deep transverse perineal muscle.
3. The bulbo-urethral (Cowper's) glands.
4. The internal pudendal vessels, the dorsal nerves of the penis, and the arteries to the bulb.

Dissection.—To expose these parts, on one side, reflect the inferior fascia of the urogenital diaphragm on that side, but carefully preserve the fascia on the opposite side, so that it may serve as a landmark in the subsequent dissection of the pelvis. On the side selected detach the fascia from the pubic arch, and, cautiously raising it from the subjacent structures, throw it medially towards the bulb.

As soon as the inferior fascia of the diaphragm is raised the muscles of the diaphragm come into view. They are small and difficult to dissect, therefore great care must be exercised as an attempt is made to clean them and to define their limits. Commence with the deep transverse muscle, which lies parallel with the base of the inferior fascia. Its posterior border is not difficult to define. Its anterior border blends with the sphincter muscle of the membranous urethra, which occupies the anterior part of the deep pouch. Clean the superficial surfaces of both muscles.

M. Transversus Perinei Profundus et M. Sphincter Urethræ Membranaceæ (O.T. Compressor Urethræ Muscle).—The deep transverse muscle of the perineum is a small fan-shaped muscle which lies between the fasciæ of the urogenital diaphragm. It has a tendinous origin from the margin of the pubic arch at the junction of the pubic and ischial rami. Expanding as it passes medially, it unites with its fellow of the opposite side in a median raphe, below and behind the membranous part of the urethra. Its posterior border lies in the angle between the inferior and superior fasciæ of the urogenital diaphragm, and its anterior border is blended with the external layer of the sphincter muscle of the membranous urethra. The *sphincter of the membranous urethra* consists of internal and external groups of fibres. The internal group is formed of circular fibres which embrace the urethra; they are continuous above with the muscular fibres of the prostate and below with the circular muscular fibres around the posterior part of the cavernous portion of the urethra. The external layer consists of transverse fibres which arise, together with the deep transverse muscle of the perineum, from the margin of the pubic arch and from the inferior fascia of the urogenital diaphragm. As they approach the median plane some of the fibres pass anterior and some posterior to the membranous part of the urethra, and they blend with the corresponding fibres of the opposite side. Both muscles are supplied by one or two delicate twigs from the *perineal division* of the *pudendal nerve*.

Dissection.—Clean the internal pudendal artery, following it forwards, from the point where it enters the postero-lateral angle of the deep pouch (Fig. 83) to its terminal division into the dorsal and profunda arteries of the penis. At the same time clean the dorsal nerve of the penis which lies lateral to the internal pudendal artery. Next secure the branch from the internal pudendal artery to the bulb of the urethra, and follow it medially through the fibres of the deep transverse muscle. As the artery approaches the bulb look for the bulbo-urethral gland, which lies a little posterior and lateral to the urethra, under cover of the posterior fibres of the deep transverse muscle. The staff, introduced at the commencement of the work, is still in the urethra, therefore the position of the membranous part of that canal is easily defined by pressing the tip of the index finger against the staff as it lies in the deep pouch of the urogenital triangle.

Art. Pudenda Interna (O.T. Internal Pudic).—The internal pudendal artery is a branch of the hypogastric. It

is met with in three different regions of the body—viz., (1) within the cavity of the pelvis; (2) in the gluteal region, where it lies upon the spine of the ischium; and (3) in the perineal space. It is consequently described as consisting of a *pelvic*, a *gluteal*, and a *perineal part.* The *perineal* or *third part* of the pudendal artery enters the perineum by passing through the lesser sciatic foramen. At first it is placed deeply; but it becomes more superficial as it passes forwards, and, at the same time, it inclines medially, so that, at its termination, it is not far from the middle line of the body.

In the rectal triangle the pudendal artery is contained in the canal in the obturator fascia, on the lateral wall of the ischio-rectal fossa. There it lies fully 38 mm. (an inch and a half) above the level of the lowest part of the ischial tuberosity, and is accompanied by two veins and the two divisions of the pudendal nerve. Of the latter the dorsal nerve of the penis lies above it and the perineal nerve below it. Reaching the base of the urogenital triangle, the pudendal artery insinuates itself between the two fasciæ of the urogenital diaphragm, and, gradually emerging from under cover of the bone, proceeds forwards along the edge of the pubic arch to a point about half an inch below the symphysis; there it pierces the inferior fascia of the urogenital diaphragm, and immediately ends, under cover of the crus penis, by dividing into two branches, viz.—(1) the profunda penis artery, which supplies the corpus cavernosum penis, and (2) the dorsal artery of the penis (Fig. 83, p. 172). In not a few cases it divides while still between the two fasciæ of the urogenital diaphragm, and its two terminal branches pierce the inferior fascia of the diaphragm separately.

Branches of the Internal Pudendal Artery.—The pudendal artery has already been seen to give off the *inferior hæmorrhoidal*, and the *perineal arteries*, and to divide into its two terminal branches—the *dorsal artery of the penis* and the *deep artery of the penis.* Between the fasciæ of the urogenital diaphragm it gives origin to the *artery to the bulb.*

The *artery to the bulb* is a short, wide vessel which springs from the internal pudendal artery about 5 mm. (one-fifth of an inch) above the level of the base of the urogenital diaphragm. It passes medially, between the two fasciæ of the diaphragm, and, giving a small twig to the bulbo-urethral gland, it enters

the substance of the bulb. It supplies the corpus cavernosum urethræ with blood (Figs. 83, 110).

The *deep artery of the penis*, immediately after its origin, pierces the medial aspect of the crus penis, and is carried forwards in the substance of the corpus cavernosum penis, which it supplies with blood (Figs. 102, 110).

The *dorsal artery of the penis* runs forwards in the interval between the crura penis, and, passing between the two layers

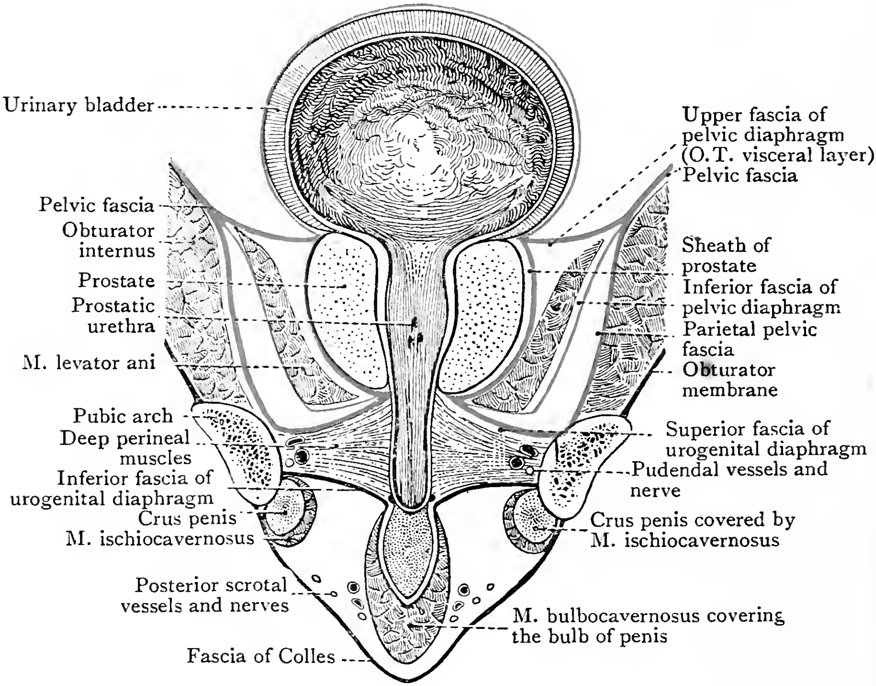

FIG. 84.—Vertical section (schematic) through the pubic arch to show the two perineal compartments

of the suspensory ligament of the penis, gains the dorsum of the penis, where it will be afterwards traced (Fig. 102).

N. Pudendus (O.T. **Pudic Nerve**).—The pudendal nerve is a branch of the sacral plexus. Following the internal pudendal artery it enters the canal in the obturator fascia, and, after giving off the *inferior hæmorrhoidal nerve*, it divides into two terminal divisions, viz.—(1) the perineal nerve, and (2) the dorsal nerve of the penis.

The *perineal nerve* has been seen to break up into the following branches:—

Cutaneous. Posterior scrotal.

Muscular.
1. Nerve to the bulbo-cavernosus.
2. Nerve to the ischio-cavernosus.
3. Nerve to the transversus perinei superficialis.
4. Nerve to the transversus perinei profundus.
5. Nerve to the sphincter urethræ membranaceæ.

Nerves to the bulb of the urethra.

It supplies also one or two branches to the bulb and the corpus cavernosum urethræ.

The *dorsal nerve of the penis* follows the pudendal artery between the two fasciæ of the urogenital diaphragm, where it lies more completely under shelter of the side of the pubic arch than the artery. Finally, piercing the inferior fascia of the diaphragm, about half an inch below the symphysis pubis, it accompanies the dorsal artery of the penis. At the root of the penis it supplies one or two twigs to the corpus cavernosum penis.

Glandulæ Bulbo-urethrales (O.T. **Cowper's Glands**).—As a general rule, the bulbo-urethral glands can readily be detected by raising the posterior fibres of the deep transverse perineal muscles. They are small lobulated bodies of a deep yellow colour, and resemble peas, both in size and in shape. They are placed, one on each side of the middle line, immediately below the membranous part of the urethra, and are overlapped by the posterior part of the bulb—separated from it, however, by the inferior fascia of the urogenital diaphragm. Each gland has a very delicate and relatively long duct which is difficult to find. The duct does not open into the membranous part of the urethra, but passes forwards at the side of the urethra, through the inferior fascia of the urogenital diaphragm, to open into the floor of the penile part of the urethra 25 mm. (one inch) beyond the diaphragm (Figs. 200 and 203).

Pars Membranacea Urethræ (Membranous Portion of the Urethra).—The canal of the urethra is subdivided for descriptive purposes into three parts, according to the structures which are in relation to its walls, as it passes from the bladder to its termination on the glans penis. These are—(1) the prostatic portion; (2) the membranous portion; and (3) the cavernous portion. Each of the subdivisions has a very definite relation to the urogenital diaphragm; the prostatic part is placed *above and posterior to* both fasciæ of the diaphragm; the membranous part is situated *between* the

two fasciæ; whilst the cavernous portion lies *anterior and inferior to* the diaphragm (Fig. 85).

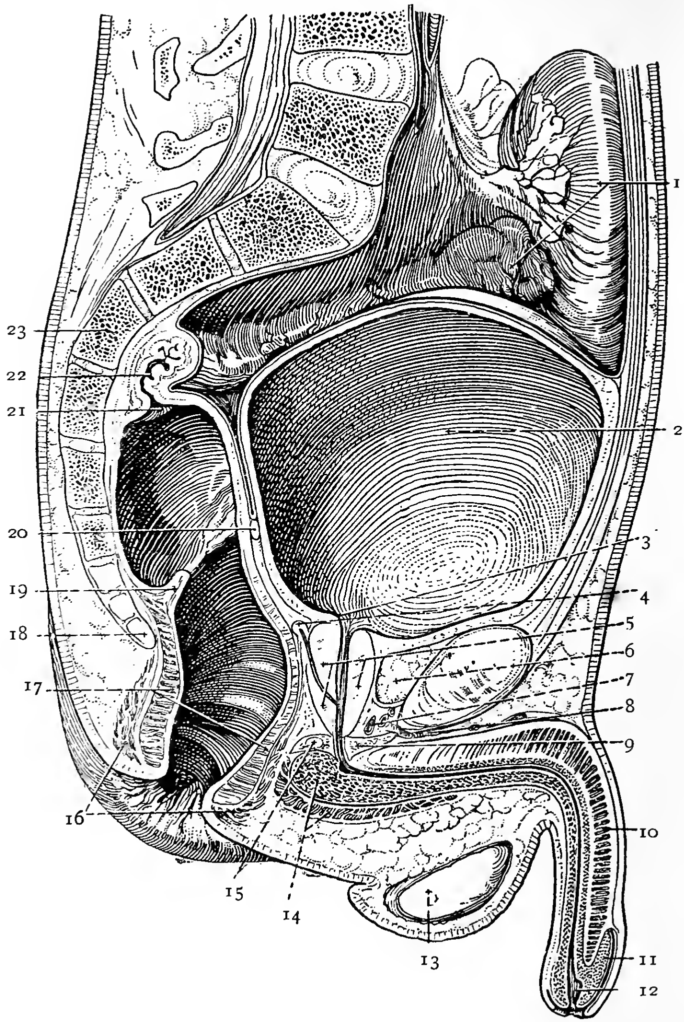

FIG. 85.—Sagittal section of the Pelvis of a young Male Adult with distended Bladder and Rectum.

1. Pelvic colon.
2. Urinary bladder.
3. Uvula of bladder.
4. Seminal vesicle.
5. Prostate.
6. Retro-pubic fat.
7. Pudendal plexus of veins.
8. Dorsal vein of penis.
9. Sphincter urethræ around membranous part of urethra.
10. Corpus cavernosum penis.
11. Glans penis.
12. Fossa navicularis of urethra.
13. Testis.
14. Bulb of the urethra and bulbo-cavernosus muscle.
15. Bulbo-urethral gland.
16. External sphincter.
17. Internal sphincter.
18. 4th piece of coccyx.
19. 2nd transverse rectal fold.
20. Ductus deferens.
21. 1st transverse rectal fold.
22. Commencement of rectum.
23. 3rd sacral vertebra.

Now that the inferior fascia of the diaphragm is removed upon one side, the student can, with the point of the finger, readily feel the staff as it lies within the membranous portion of the urethra. He should examine the surroundings of that canal. It is the shortest subdivision of the urethra, and is about one inch distant from the symphysis pubis. Throughout its entire extent it is enveloped by the fibres of the sphincter muscle, and on that account it is sometimes

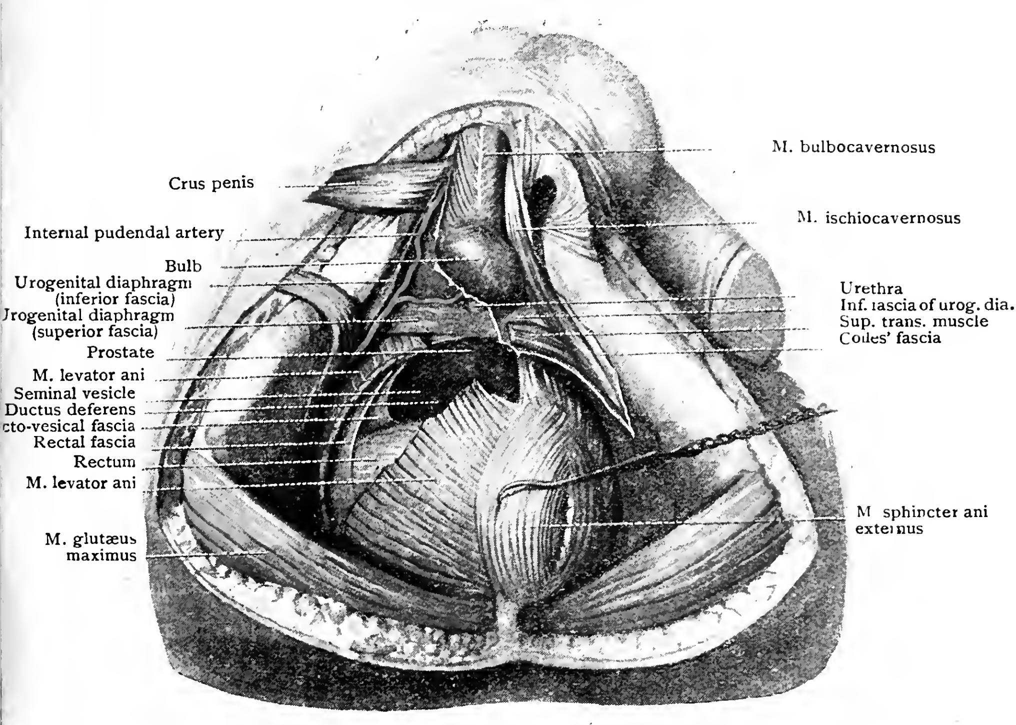

FIG. 86.—Dissection to expose the Prostate from the Perineum.

called the muscular part of the urethra. On each side, and at a lower level, is a bulbo-urethral (Cowper's) gland, whilst between it and the symphysis pubis is the dorsal vein of the penis, which is separated from it by the transverse ligament of the pelvis.

Vasa Lymphatica Perinei.—The lymph vessels of the perineum cannot be displayed in an ordinary dissection, but they are present in great numbers, and the dissectors should remember that the greater part of the lymph from the perineal region is eventually discharged into the proximal group of superficial subinguinal lymph glands which lie in the fat in

the upper part of the front of the thigh. It is the enlargement of these glands, therefore, which frequently gives the first intimation of the spread of microbic infection and the migration of the cells of malignant growths from the tissues and organs of the perineal region. They receive lymph from the whole of the skin, the fasciæ, and the muscles of the perineum, and also from the skin of the scrotum, penis, and pubis. They also receive lymph from the body and root of the penis, from the penile part of the urethra, and from the terminal part of the anal canal.

The dissection of the perineum, to the extent usually possible in three days, is now completed, and the student should notice that in the urethral triangle he has opened two fascia-bounded compartments. The superficial compartment lies between Colles' fascia and the urogenital diaphragm. Posteriorly this is closed by the union of the fascia and the diaphragm. Laterally it is closed by the attachment of the fascia and the diaphragm to the rami of the ischium and pubis. Anteriorly, since the fascia of Colles is continuous with the deep layer of the superficial fascia of the abdominal wall, the pouch is open, and fluid poured out into it can pass upwards to the abdominal wall. For the contents of the pouch see p. 154. The deep pouch lies between the two fasciæ of the urogenital diaphragm. It is closed posteriorly and anteriorly by the fusion of the posterior and anterior margins of the two fasciæ, and laterally by the attachment of the two fasciæ of the diaphragm to the rami of the pubis and ischium. For the contents of the deep compartment see p. 165. Above the superior wall of the deep compartment lie the apex of the prostate gland and the anterior borders of the levatores ani muscles. To approach the prostate, therefore, through the urethral triangle, a series of alternating fascial and muscular strata would have to be divided, viz.—

1. The fascia of Colles.
2. The superficial perineal muscles.
3. The inferior fascia of the urogenital diaphragm.
4. The deep transverse perineal muscle and the sphincter of the membranous urethra.
5. The superior fascia of the urogenital diaphragm.

This, however, is not a practicable way of approaching

the prostate, and the method which should be adopted to display the posterior surface of the gland will be described when the investigation of the pelvic fascia is undertaken (see p. 418).

A pad of tow, soaked in preservative mixture, should be placed in the perineum, and the flaps of skin carefully stitched over it. On the *fourth day* after the body has been brought into the dissecting-room, it is placed upon its back, and the dissectors of the abdomen commence work upon the abdominal wall, p. 197.

FEMALE PERINEUM.

The boundaries of the female perineum are identical with those in the male (p. 147). The region is wider, however, and of greater extent. For purposes of description it is subdivided, by an imaginary transverse line drawn in front of the anus and the tuberosities of the ischia, into a *posterior*, *anal triangle*, and an *anterior*, *urogenital triangle*.

External Anatomy.—The anal triangle presents the same points for consideration as in the male. The external anatomy of the urogenital triangle demands careful study, because it includes the urethral opening and the external organs of generation. The latter are—

1. The mons pubis.
2. The labia majora.
3. The labia minora.
4. The clitoris.
5. The urethral opening.
6. The vaginal orifice.

All the parts mentioned are included under the common term of *pudendum muliebre* or *Vulva*.

Mons Pubis (O.T. **Mons Veneris**).—The mons pubis is a marked cushion-like eminence situated in front of the pubes. The projection is due to a collection of adipose tissue under the integument. It is covered with hair.

Labia Majora Pudendi.—The labia majora correspond to the two halves of the scrotum, separated from one another by a median cleft. They are two rounded folds, which commence anteriorly at the mons pubis, where they meet in the *anterior commissure*. From the anterior commissure they extend downwards and backwards towards the anus. As they proceed backwards they diminish in thickness, and they meet posteriorly in the *posterior commissure*. Laterally they

are covered by skin studded with scattered hairs, whilst medially they are coated with smooth humid integument, the free surface of which is lubricated by a semi-solid secretion, derived from numerous sebaceous glands which open upon it. During parturition the labia majora are unfolded, and thus give the vagina a greater capability of dilatation.

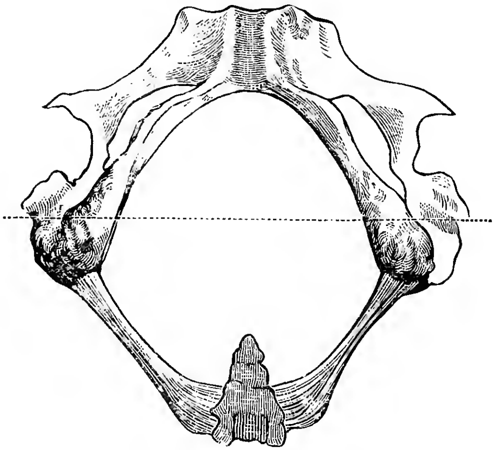

FIG. 87.—Outlet of Female Pelvis.

The labia majora enclose an elliptical fissure, which is termed the *rima pudendi*, or the *urogenital fissure*, on account of its containing the apertures of the urethra and vagina.

Labia Minora Pudendi.—The labia minora are two pendulous folds of integument which lie between the labia majora. They represent the prepuce and part of the ventral portion of the penis of the male. To display them fully the labia majora must be pulled apart; then they will be seen, placed one on each side of the vaginal orifice. As they pass forwards they become more prominent, and at the same time converge towards one another. When they reach the clitoris, each terminates by splitting into two divisions or folds. The smaller and lower folds are attached to the inferior surface of the clitoris, where they form the *frenulum clitoridis*. The upper fold arches over the clitoris like a hood, and unites with the corresponding fold of the opposite side to form the *præputium clitoridis*.

A short distance in front of the posterior commissure the posterior extremities of the labia minora are usually connected together by a transverse fold, the *frenulum labiorum pudendi*, and immediately anterior to and above that fold, between it and the posterior border of the orifice of the vagina, is a depression, the *fossa navicularis*.

The frenulum pudendi may be absent, and if present it is usually ruptured during the first labour.

It may be well for the student to bear in mind that the term "perineum" is used by obstetric surgeons in a very restricted sense. It is applied by

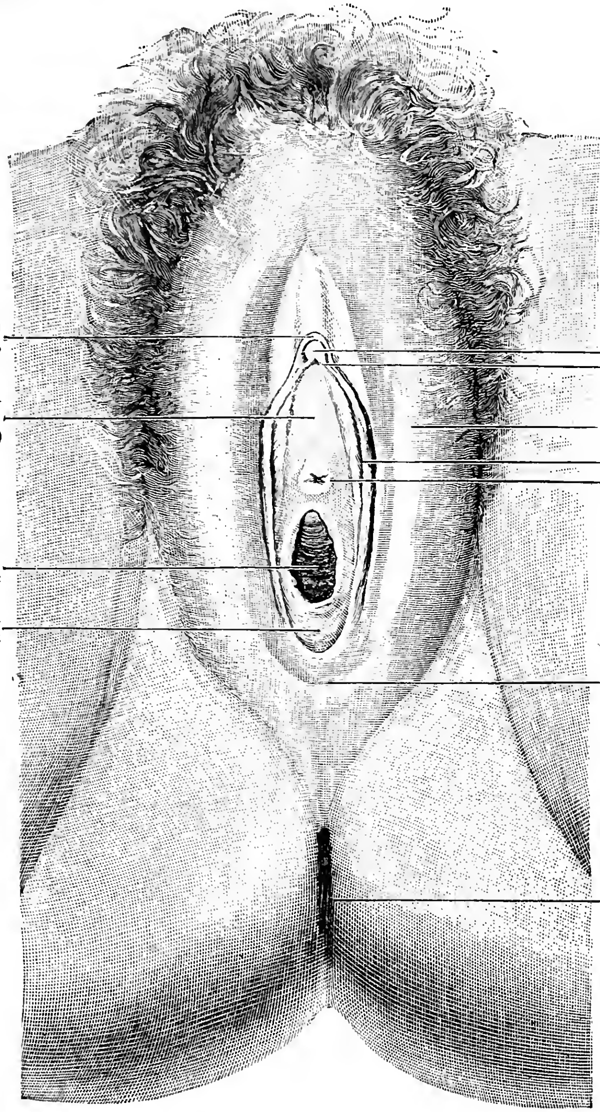

FIG. 88.—Female External Genital Organs.

The frenulum labiorum pudendi is seen stretching across behind the fossa navicularis and in front of the posterior commissure. The ducts of the greater vestibular glands open in the intervals between the vaginal orifice and the medial edges of the labia minora. (Dixon.)

them to the small region between the anus and the frenulum labiorum pudendi.

Clitoris.—The clitoris is the homologue of the penis, and, notwithstanding its diminutive proportions, it presents a close resemblance to the male organ both in appearance and structure. It is a minute elongated projection placed behind the anterior commissure, and surmounted by a sensitive rounded tubercle called the *glans*; but it is not traversed by the urethra. The manner in which its prepuce and frenulum are formed has already been described. To obtain a proper view of the clitoris the dissectors must lay hold of the glans with the forceps and draw it out from the prepuce.

Vestibule.—The term vestibule is applied to the region which lies between the labia minora and extends from the clitoris in front to the frenulum labiorum pudendi behind. When the labia minora are pulled apart it appears as a triangular interval. The vagina, the urethra, and the ducts of the greater vestibular glands open into it. The vagina opens into the posterior part from above. The urethral opening is directly in front of the vaginal opening in the median plane. The duct of the corresponding larger vestibular gland opens, on each side, in the angle between the vaginal orifice and the labium minus. In front of the orifice of the urethra, when the labia minora are pulled apart, there is a smooth triangular piece of mucous membrane which forms the upper boundary of the anterior part of the vestibule between the opening of the urethra and the clitoris. The vestibule opens below into the cleft between the labia majora (Fig. 226).

Orificium Urethræ.—The orifice of the urethra lies close to the opening of the vagina, about 25 mm. (one inch) behind the clitoris. It usually presents the appearance of a vertical slit, and the mucous membrane around it is prominent, pouting, and slightly puckered, so that when the tip of the finger is passed over the roof of the anterior part of the vestibule the opening can readily be distinguished by touch.

Orificium Vaginæ.—The vaginal orifice, in the virgin, is partially closed by the *hymen*—formed by two semilunar folds of mucous membrane attached to the sides of the entrance to the vagina, and united together anteriorly and posteriorly. The form of the hymen, however, is very variable. Sometimes it is present in the shape of a septum attached around the entire circumference of the vaginal entrance, but pierced in the centre by a circular opening or an antero-

posterior slit; again, it may be cribriform, or fringed along its free margin. Lastly, it may constitute a complete septum across the opening of the vaginal canal. In that case awkward results ensue from the retention of the menstrual fluid. After it has been ruptured its position is marked by certain rounded elevations which have received the name of *carunculæ hymenales*.

Close to each side of the vaginal orifice, in the groove between it and the posterior part of the labium minus, is the opening of the duct of the *greater vestibular* (*Bartholin's*) *gland*, an orifice just visible to the naked eye.

Passage of Catheter and Examination of Orificium Externum Uteri.—The dissector should now practise the passing of the female catheter, and afterwards introduce a speculum into the vagina, to obtain a view of the orificium externum uteri.

Before the catheter is passed, the forefinger of the left hand should be placed in the orifice of the vagina, with its palmar surface directed upwards towards the pubes. If the instrument is now directed along this finger and the point raised slightly, when it reaches the entrance to the vagina, a little manipulation will cause it to enter the urethra.

When the speculum is introduced into the vagina, the points to be noted in connection with the external orifice of the uterus are:—(1) the small size of the opening; (2) the two rounded and thick lips which bound the aperture. Both in the virgin and in women who have borne children it is a transverse cleft, but in the former it is small and its anterior and posterior lips are smooth and rounded, whilst in the latter it is usually larger and its lips are frequently cleft and scarred. Note, further, that the anterior lip is the thicker and shorter of the two.

Dissection.—**Reflection of Skin.**—The anal canal should be slightly filled with tow, and the anal orifice stitched up, then the margins of the labia minora should be stitched together.—Incisions—(1) A transverse incision should, in the first place, be carried from one ischial tuberosity to the other, in front of the anus. (2) The urogenital fissure and the orifice of the anus should next be closely encircled by incisions, and these joined by a cut along the median plane. (3) Lastly, carry an incision forwards from the second or third piece of the coccyx along the median plane to the cut which surrounds the anus.

Four flaps are thus marked out; the two anterior may be thrown forwards and laterally, and the two posterior backwards and laterally.

Panniculus Adiposus (Superficial Fascia).—The superficial fascia of the perineum is now laid bare. In the anal triangle it agrees in every particular with the same portion of fascia in the male (p. 151). In the anterior or urogenital triangle, however, owing to the difference in the external organs of generation, there is a slight modification. It presents the same two layers. In the superficial fatty layer, where it covers the labia majora, there are *dartos fibres* similar to those in the scrotum of the male. The deeper layer has the same attachments as in the male, viz., to the margins of the pubic arch, and to the base of the urogenital diaphragm; but it is not so membranous, and consequently does not form so distinct a stratum. The two superficial fascial pouches are also present in the female, and are sometimes spoken of as the *vulvo-scrotal sacs.* Their separation along the median plane is not due to the interposition of a median septum, as in the male, but to the presence of the urogenital fissure. They are not so easily demonstrated as in the male, but an attempt should be made to investigate them.

Dissection.—Cut through the fatty layer of the superficial fascia of the urogenital triangle until the deeper membranous layer (Colles' fascia) is exposed. Make a small longitudinal incision through Colles' fascia and introduce the tip of the little finger through it, then attempt to pass the finger medially, laterally, backwards, upwards, and forwards. Medially its passage beyond the median plane is prevented by the wall of the urogenital cleft. Laterally, it cannot be passed into the medial part of the thigh because Colles' fascia is attached to the margins of the rami of the pubis and ischium. It cannot pass backwards, beyond the anterior boundary of the anal triangle, because there Colles' fascia unites with the base of the fascia of the urogenital diaphragm. Upward pressure, towards the pelvis, will demonstrate the presence of the strong inferior fascia of the urogenital diaphragm which forms the upper boundary of the superficial pouch of the urogenital triangle on each side, and prevents the finger passing upwards into the pelvis; but when the tip of the finger is directed forwards it will be found that it can be passed in front of the apex of the pubic arch and then upwards in front of the symphysis to the region of the anterior wall of the abdomen. As the finger lies in front of the symphysis it can be passed across to the opposite side of the median plane, but it cannot be passed laterally into the thigh because the deep layer of the superficial fascia is attached to the front of the body of the pubis.

The dissector who has followed the above instructions, successfully, will have demonstrated the presence of the superficial pouch of the urogenital triangle in the female and its

division into right and left parts by the urogenital cleft. In the male the pouch is less completely divided than in the female; the boundaries of its anterior part are enlarged to form the scrotum in which the male genital glands (the testes) are lodged, and it is of special interest in relation with the extravasation of urine from a ruptured urethra. In the female each half of the pouch lies in the corresponding labium majus. Extravasation of urine into it does not occur, but it is of interest in association with the fact that occasionally the female genital gland (the ovary) descends into it instead of remaining in the pelvis. The descent of the ovary into the superficial pouch of the urogenital triangle is abnormal, but its occurrence should be remembered in order that mistakes of diagnosis may be avoided.

Anal Triangle.

Nothing need be added to what has already been written regarding this portion of the perineal space in the male. In both sexes the steps of the dissection and the parts found are precisely the same (*vide* p. 155).

Urogenital Triangle.

Superficial Perineal Vessels and Nerves. — Under this heading are included:—

Arteries. { The superficial perineal artery.
The transverse perineal artery.

Nerves. { The posterior labial nerves.
The long perineal branch of the posterior cutaneous nerve of the thigh.

The vessels and nerves mentioned lie, as in the male, in the superficial pouch of the urogenital triangle, but they are smaller than the corresponding structures in the male and are distributed to the labia majora instead of to the scrotum.

Dissection.—The superficial or posterior labial branches of the perineal nerve have already been secured in the antero-lateral angle of the ischio-rectal fossa (see p. 158). Now follow them forwards into the superficial pouch of the urogenital area. They are accompanied by the superficial branch of the perineal artery which must be cleaned at the same time. As the posterior labial nerves are traced forwards they will be found to be joined,

on the lateral side, by the long perineal branch of the posterior cutaneous nerve of the thigh, which pierces Colles' fascia about 25 mm. (one inch) anterior to the tuberosity of the ischium. Secure that nerve and follow it forwards to its termination, but do not interfere with it in the thigh, where it belongs to the dissector of the inferior extremity.

For the detailed description of the vessels and nerves exposed by the above dissection the dissectors must refer to

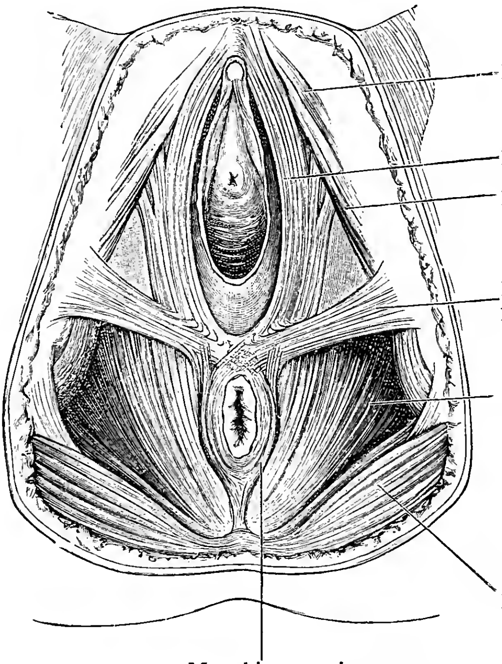

FIG. 89.—Muscles of the Female Perineum (Peter Thompson).

p. 162, where the corresponding structures are described in the male.

Dissection.—Divide the posterior labial nerves and the accompanying vessels near their anterior ends and turn them backwards; then clean the *superficial perineal muscles.* They are, on each side—(1) the ischio-cavernosus, (2) the bulbo-cavernosus, and (3) the superficial transverse muscle. The ischio-cavernosus lies along the pubic arch on the surface of the crus of the clitoris. The bulbo-cavernosus is placed medially on the surface of the bulb of the vestibule which lies along the sides of the vestibule. The superficial transverse muscle runs from the posterior end of the ischio-cavernosus to the central point of the perineum, which lies in the median plane midway between the vaginal and anal orifices.

Whilst cleaning the muscles secure the nerve twigs which are given to them from the deep divisions of the perineal branch of the pudendal nerve.

M. Transversus Perinei Superficialis.—The superficial transverse perineal muscle has the same disposition as in the male, but it is rare to find it so well marked in the female. In most subjects its fibres are pale, and it is generally very difficult to define. It is a slender fasciculus which takes origin from the medial surface of the ramus of the ischium, close to the tuberosity, and passes obliquely medially to its insertion into the central point of the perineum.

In the female the central point of the perineum is between the posterior labial commissure and the anus.

M. Ischio-cavernosus.—The ischio-cavernosus is much smaller than the corresponding muscle in the male. It arises from the medial aspect of the ramus of the ischium close to the tuberosity, and is inserted by a tendinous expansion on the surface of the crus of the clitoris.

M. Bulbo-cavernosus.—The bulbo-cavernosus (O.T. *sphincter vaginæ*) is a true sphincter muscle. It consists of two halves, which are placed one on each side of the vestibule, closely adapted to the surfaces of the two halves of the bulb of the vestibule. Posteriorly the fibres of opposite sides unite behind the vaginal opening, and are attached to the central point of the perineum, some of the fibres intermixing with those of the sphincter ani. Anteriorly the two portions of the muscle become narrower, and, converging towards the middle line, are attached to the sides of the clitoris. In some cases a small fasciculus, on each side, may be observed to reach the dorsum of the clitoris and there gain insertion into a tendinous expansion which lies superficial to the dorsal vein. That fasciculus is comparable to the anterior fibres of the bulbo-cavernosus of the male, which embrace the body of the penis (see p. 167).

On each side of the urogenital area the three superficial muscles of the perineum form the boundaries of a small triangular area. The tip of the index finger should be placed in the triangle and should be pushed upwards towards the pelvis. The resistance which will be met with is caused by the inferior fascia of the urogenital diaphragm, which will be investigated after the contents of the superficial pouch have been examined.

Perineal Body.—It has been already stated that the term "perineum" is confined by the obstetrician to the area between the frenulum pudendi and the anus. At this stage of the dissection it will be obvious that the region in question is occupied by an indefinite mass of fibrous and muscular tissue, which occupies the interval between the anal canal and the vagina. The mass is known as the *perineal body*. Muscular tissue belonging to the sphincter ani, levatores ani, and bulbo-cavernosus, together with the central point of the perineum, enter into its constitution.

> ***Dissection.***—**The bulbo-cavernosus should now be carefully raised from the surface of the bulb of the vestibule, and the ischio-cavernosus from the surface of the crus clitoridis. The transversus perinei superficialis may be removed at the same time.**

Bulbus Vestibuli.—When the above dissection is completed the bulb of the vestibule is displayed. It consists of two oblong bodies, composed of erectile tissue, placed one on each side of the vestibule and entrance to the vagina. Each half is invested by a fibrous capsule which binds it closely to the inferior surface of the inferior fascia of the urogenital diaphragm. It is relatively broad posteriorly, but narrows as it passes forwards, and in front, between the urethra and the clitoris, the two halves are united by a venous plexus, called the *pars intermedia*, which is itself continuous in front with the glans of the clitoris. The details of the connections mentioned cannot usually be seen in an ordinary dissecting-room part, but they are quite obvious in a specially injected specimen.

The posterior end of each half of the bulb of the vestibule is in contact with and partially overlaps the corresponding larger vestibular gland (Bartolini). The lateral, convex surface is covered by the bulbo-cavernosus muscle and the medial surface is in contact with the wall of the vestibule at its junction with the vagina (Fig. 90).

The arrangement of erectile tissue of the bulb of the vestibule in the female corresponds, more or less closely, with the condition present in the bulb of the urethra in the male. The apparent dissimilarity is due to the presence of the urogenital fissure and orifice of the vagina. Suppose, for a moment, that the latter was obliterated and that the vestibule was closed to form a canal which carried the urethra forwards to

the extremity of the clitoris. The two halves of the bulb would then be in contact with each other, and its entire surface would be covered by a muscular stratum, after the manner of the bulb and bulbo-cavernosus in the male. Further, the urethra would be surrounded by erectile tissue, and the pars intermedia would correspond, to some extent, to that portion of the corpus cavernosum urethræ which, in the male, lies in front of the bulb and becomes continuous with the glans penis.

Dissection.—If the stitches which were used to close the vestibule have not been removed take them away now. Then to display the constitution of the clitoris strip the skin away from the body of the clitoris. Next dissect away the areolar tissue from the body of the clitoris, but do not injure the dorsal vein of the clitoris which lies in the median plane on the dorsal aspect, the dorsal arteries and nerves which lie at the sides of the vein, and the suspensory ligament which attaches the clitoris to the front of the symphysis pubis.

Clitoris.—The *body of the clitoris*, which is about 38 mm. (an inch and a half) long, is bent in a downward direction on itself, at the lower border of the symphysis pubis. It consists of a cylindrical mass of erectile tissue called the *corpus cavernosum clitoridis*, and is homologous with the corpus cavernosum penis. Along the middle line it is partially separated into right and left halves by an imperfect *septum*. Anteriorly it terminates in a small rounded tubercle, which bears the name of the *glans clitoridis*. The glans, however, is not structurally continuous with the corpus cavernosum. It is a little mass of erectile tissue continuous with the pars intermedia, and fitting into a slight concavity which is formed for its reception on the extremity of the corpus cavernosum. Posteriorly, opposite the lower part of the symphysis pubis, the corpus cavernosum separates into two parts, the *crura clitoridis*, which diverge widely from each other. Each crus is attached by its deep surface to the rami of the pubis and ischium, and is covered by the corresponding ischio-cavernosus muscle.

The clitoris, then, consists of three parts:—(1) *a glans* continuous with the pars intermedia; (2) *a body*; and (3) *two crura*, attached to the sides of the pubic arch. It has been noted that the pars intermedia corresponds with part of the corpus cavernosum urethræ in the male. The clitoris in the female, therefore, closely resembles the penis in the male,

the chief differences being the diminutive size of the clitoris, and the fact that the glans clitoridis is not perforated by the urethra.

After the bulb of the vestibule and the clitoris have been studied an attempt should be made to expose the larger vestibular gland and the superficial surface of the inferior fascia of the urogenital diaphragm.

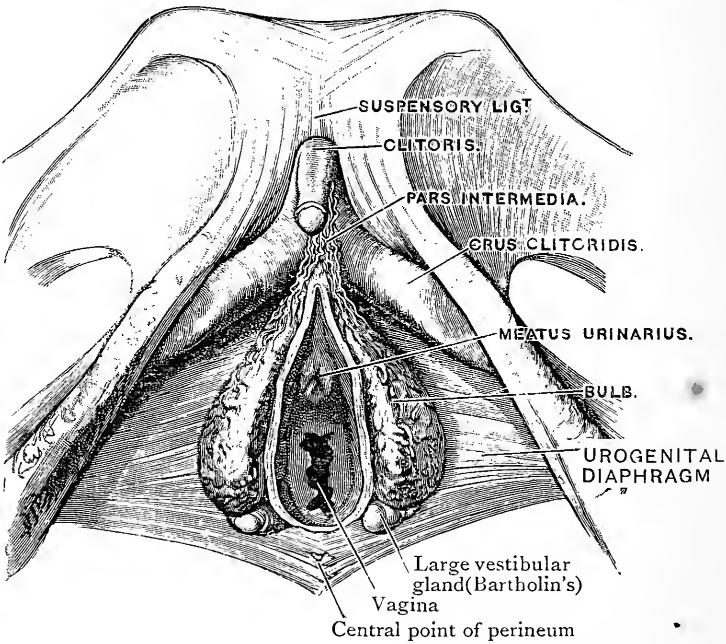

FIG. 90.—Dissection of Female Perineum to show the Clitoris and the Bulb of the Vestibule.

Dissection.—Clear away the areolar tissue at the posterior end of the bulb of the vestibule, and expose the larger vestibular gland. The duct of the gland is long but thin, and is not easily found. It issues from the anterior part of the gland, and the posterior end of the bulb of the vestibule must be raised to expose it. Whilst raising and turning forwards the posterior end of the bulb look for the artery to the bulb, which pierces the inferior fascia of the urogenital diaphragm. After the artery to the bulb has been secured detach the crus of the clitoris from the rami of the ischium and pubis. Commence at the posterior end of the crus and proceed forwards. As the anterior part of the crus is approached the anteria profunda clitoridis will be found entering the deep surface of the crus, and, immediately adjacent to it, the dorsal artery and nerve of the clitoris will be seen passing forwards to the dorsum of the clitoris. Now divide the artery to the bulb of the vestibule, detach the bulb from the

inferior fascia of the urogenital diaphragm and turn it forwards. When the crus of the clitoris and the bulb of the vestibule have both been separated from their attachments and turned forwards the superficial surface of the inferior fascia of the urogenital diaphragm will be exposed.

Glandulæ Vestibulares Majores (O.T. **Bartholin's Glands**).—The greater vestibular glands are the representatives of the bulbo-urethral glands of the male. They are placed one upon each side of the entrance to the vagina, immediately behind the rounded posterior end of the bulb of the vestibule, and under cover of the bulbo-cavernosus. Each is a round or oblong body, about the size of a bean; a long duct proceeds from it, and opens in the angle between the labium minus and the hymen or carunculæ hymenales (Fig. 90, p. 192).

Urogenital Diaphragm.—Owing to the greater width of the pubic arch, the urogenital diaphragm is more extensive in the female than in the male (see Fig. 90). It does not possess the same strength, however, and is not so perfect, seeing that it is pierced by the vaginal canal. As in the male the diaphragm consists of a muscular layer enclosed between a superior and an inferior fascia. The muscular layer consists of the deep transverse perineal muscle and the sphincter of the membranous part of the urethra. The superior and inferior fasciæ are blended in front, a short distance below the arcuate ligament at the apex of the pubic arch, to form the *transverse ligament of the pelvis.* They are blended again behind, along the line of separation between the urogenital and anal triangles, at the base of the urogenital diaphragm, where they fuse also with Colles' fascia. Both the superior and the inferior fascia are attached laterally to the rami of the pubis and ischium; therefore the fasciæ enclose a space, called *the deep pouch of the urogenital triangle.* The pouch is occupied by the muscles of the diaphragm. It is traversed by the vagina, the urethra; the internal pudendal artery, and the dorsal nerve of the clitoris. The antero-posterior and transverse extents of the pouch are considerable, but the distance between the superior and inferior fascia, where they are widest apart, is not more than about 20 mm. (four-fifths of an inch); consequently, as both the vagina and the urethra pass perpendicularly through the diaphragm, they lie for only a short distance in the deep pouch.

The superior fascia of the diaphragm is part of the parietal pelvic fascia, which lines the inner surface of the pelvic wall; it will be dealt with again when the pelvic fascia is dissected (p. 418). The inferior fascia is on the same morphological plane as the obturator membrane, and like that membrane it partially fills a gap in the bony wall of the pelvis. Its base is fused with the Colles' fascia, and it is pierced by the deep branch of the perineal nerve and by the perineal artery. The posterior labial nerves cross the base of Colles' fascia. Its blunted apex is blended, as already stated, with the superior fascia to form the transverse ligament of the pelvis, and between it and the arcuate ligament of the pubis there is a small space through which the dorsal vein of the clitoris passes backwards to join the vesical plexus. The inferior fascia is pierced, in the median plane, about 27 mm. (a little more than one inch) below the apex of the pubic arch by the vagina, and, immediately in front of the vagina, by the urethra. At each side of the vagina it is pierced by the artery to the corresponding half of the bulb of the vestibule, and, a short distance below the apex, on each side, it is pierced by the dorsal nerve of the clitoris, and either by the terminal part of the internal pudendal artery or by its two end branches, namely, the dorsal and deep arteries of the clitoris.

Dissection.—The inferior fascia of the urogenital diaphragm should be reflected upon one side. Detach it from the margin of the pubic arch and throw it medially; then, if the muscles are in good condition, clean them. After the muscles are cleaned, follow the artery of the bulb, laterally, to its origin from the internal pudendal artery, and then clean the internal pudendal artery from behind forwards to its termination. It lies in the lateral margin of the pouch, close to the pubic arch, and is accompanied by the dorsal nerve of the clitoris, which must also be cleaned. When the dissection is completed, revise the structures which lie in the deep pouch, and reconsider the main points associated with the internal pudendal artery and the pudendal nerve.

M. Transversus Perinei Profundus et M. Sphincter Urethræ Membranaceæ (O.T. **Compressor Urethræ Muscle**).—The deep transverse muscle of the perineum is even smaller in the female than in the male, and is also less distinctly separable from the sphincter of the membranous part of the urethra. It arises laterally from the margin of the pubic arch, at the junction of the ischial and pubic rami, and it terminates medially on the lower part of the posterior wall of the

vagina. Its anterior fibres blend with the posterior fibres of the sphincter of the urethra. The *sphincter* consists of an internal layer of fibres arranged circularly round the urethra, and an external layer which springs from the pubic arch, anterior to the origin of the deep transverse muscle, and from the inferior fascia of the urogenital diaphragm. As the fibres of this layer approach the median plane some pass in front of the vagina and urethra, and others are attached to the posterior wall of the vagina. Both the above muscles are supplied by twigs from the perineal branch of the pudendal nerve.

Arteria Pudenda Interna et Nervus Pudendus.—The internal pudendal artery and the pudendal nerve have a disposition similar to the corresponding artery and nerve in the male (see p. 176), but they are smaller and the names of some of their branches are different, in association with the different names of the parts to which they are distributed; thus the posterior labial branches of the perineal division of the pudendal nerve of the female correspond to the posterior scrotal nerves of the male, and the dorsal nerve of the clitoris corresponds to the dorsal nerve of the penis. Similarly the posterior labial branches of the perineal artery of the female correspond to the posterior scrotal arteries of the male; the artery to the bulb of the vestibule of the female corresponds to the artery to the bulb of the urethra in the male, and the dorsal and deep arteries of the clitoris are homologous with the dorsal and deep arteries of the penis.

Nervus Perinei.—As in the male, the pudendal nerve, as it lies in the posterior part of the canal in the obturator fascia on the lateral wall of the ischio-rectal fossa, gives off its inferior hæmorrhoidal branch, and then divides into two branches, the perineal nerve and the dorsal nerve of the clitoris.

The perineal nerve runs forwards in the canal below the internal pudendal artery, and, near the anterior part of the ischio-rectal fossa, it divides into a superficial and a deep division, both of which pierce the medial wall of the canal and enter the anterior part of the fossa. The superficial division is cutaneous; it divides into the posterior labial nerves which pierce the base of Colles' fascia and run forwards in the superficial pouch of the urogenital triangle to supply the skin of the labia of the corresponding side. The deep branch is mainly muscular. It supplies twigs to

the anterior parts of the external sphincter of the anus and the levator ani; then it pierces the base of the fascia of the urogenital diaphragm, and supplies the muscles in the superficial pouch, viz., the bulbo-cavernosus, the ischio-cavernosus, and the superficial transverse muscle. It also supplies the deep transverse muscle and the sphincter of the membranous urethra, and gives a branch to the bulb of the vestibule.

Nervus Dorsalis Clitoridis.—The dorsal nerve of the clitoris runs forwards above the internal pudendal artery, and, with that artery, at the anterior end of the canal in the obturator fascia it insinuates itself between the two fasciæ of the urogenital diaphragm, between which it continues forwards along the margin of the pubic arch. About 12 mm. (half an inch) below the apex of the arch it pierces the inferior fascia of the diaphragm and passes to the dorsum of the clitoris, where it will be followed later. Whilst it is between the two fasciæ it gives a branch to the crus of the clitoris.

Dorsal Vessels and Nerves of the Clitoris.—On the dorsum of the clitoris a little dissection will display the *dorsal vein* occupying the groove in the middle line, with a *dorsal artery* and *nerve* lying upon each side of it.

The arteries and nerves should be traced forwards to their distribution in the glans.

The *dorsal vein of the clitoris* takes origin in the glans. As it proceeds backwards it receives certain superficial veins, and also tributaries from the corpus cavernosum clitoridis. At the root of the clitoris it passes between the transverse ligament of the pelvis and the arcuate ligament of the pubis, and is continued backwards into the pelvis, to join the plexus of veins on the wall of the vagina in the region of the neck of the bladder. It communicates also with the internal pudendal vein.

Urethra Muliebris.—The female urethra is a short canal, about 38 mm. (one and a half inches) in length, which extends from the neck of the bladder to its orifice in the region of the vestibule. It passes downwards and forwards behind the lower half of the symphysis pubis and the pubic arch, but it is slightly curved with concavity forwards.

At first it is situated in the pelvis, separated from the symphysis pubis by a pad of retro-pubic fat; then it pierces the superior fascia of the urogenital diaphragm and enters the deep pouch of the urogenital triangle of the perineum,

where it is surrounded by the sphincter muscle of the membranous urethra. It leaves the deep pouch by piercing the inferior fascia of the urogenital diaphragm, and at once opens into the anterior part of the vestibule. Through the whole of its extent it is closely attached to the anterior wall of the vagina.

The dissector should pass a staff through the urethra and trace its course to the bladder by means of the left index finger introduced into the vagina.

After the position of the urethra has been defined, place a pad of tow soaked in preservative solution in the perineum and stitch the skin flaps over it. On the fourth day after the body has been brought into the dissecting room, it is placed upon its back, and the dissectors of the abdomen commence work on the abdominal wall.

THE ABDOMINAL WALL.

After the dissection of the perineum is completed, the body is placed upon its back, with blocks under the thorax and pelvis, and the dissectors of the abdomen begin the dissection of the abdominal wall (Fig. 91).

External Anatomy.—It is well, however, before proceeding to the actual dissection, that some attention should be paid to the general configuration and bony prominences of the region. If the subject is obese the abdomen presents a smooth, rounded, and protuberant appearance; if, on the other hand, it is spare, the abdominal wall is depressed, and the lower margin of the thorax above, and the pubes, the iliac crests, and the inguinal ligaments below, stand out in marked relief. In the median plane the student will notice a linear depression extending downwards, from the lower end of the sternum, towards the symphysis. The depression corresponds with the position of the *linea alba*, which lies, in the median plane, between the two recti muscles.

The linea alba is important to the surgeon, because it is a fibrous portion of the abdominal wall and it is practically devoid of blood-vessels; consequently it is chosen as the region through which the trocar is introduced into the abdomen in the operation of paracentesis abdominis or tapping.

In the linear depression, rather nearer the pubis than the xiphoid process of the sternum, is the *umbilicus* or *navel*. It is a depressed and puckered cicatrix, but its floor is

frequently raised to form a little button-like knob. It forms part of the linea alba, and is the result of the closure of the umbilical orifice which existed in the abdominal wall, up to the period of birth, for the passage of the constituents of the umbilical cord, viz.—the allantois, the umbilical vein, and the two umbilical arteries. The dissector should remember that the allantois was connected with the urinary bladder, the umbilical vein with the liver, and the umbilical arteries with the hypogastric arteries. After birth the umbilical cord is severed, and thereafter its constituent parts atrophy. Those portions of them which were situated in the umbilical orifice fuse with the margin of the orifice to form the fibrous cicatrix called the umbilicus, and are no longer recognisable as distinct structures; but the parts which lie within the abdomen are recognisable throughout the whole of life, and will be found enclosed in folds of peritoneum when the abdomen is opened.

In well-developed subjects a rectus abdominis muscle stands out on each side of the median line, forming a longitudinal prominence, which is broader above than below. Its lateral margin, which forms a curved line with the concavity directed medially, corresponds with the *linea semilunaris*—*i.e.* the line along which the aponeurotic tendon of the internal oblique muscle splits to enclose the rectus abdominis. The linea semilunaris is occasionally selected by the surgeon as the site for incisions through the abdominal wall because of its slight vascularity, but it must not be forgotten that an incision of any length passing through it will necessarily divide one or more of the nerves which supply the rectus abdominis.

The dissector should note that the lateral margin of the rectus abdominis crosses the lower margin of the thorax at the level of the ninth costal cartilage, and the point of crossing, on the right side, indicates the position of the fundus of the gall-bladder.

After the regions of the linea alba and the linea semilunaris have been examined, place the index finger on the upper part of the symphysis pubis, at the lower end of the linea alba, and carry it laterally along the pubic crest to the pubic tubercle. At the pubic tubercle it will enter a linear depression which runs upwards and laterally, at the junction of the abdomen and the thigh, along the line of the inguinal ligament, to the anterior superior spine of the ilium. All the

parts mentioned can be felt if careful pressure is made. After they have been identified the dissector should endeavour to determine the position of the subcutaneous inguinal ring (O.T. external abdominal). In the male it is easily defined. Immediately lateral to the pubic tubercle the spermatic cord can be felt as it passes over the medial end of the inguinal ligament on its way to the scrotum. Take the spermatic cord as a guide, push the loose skin of the scrotum upwards along it before the finger, and the tip of the finger will enter the ring, and will be able to distinguish its sharp lower and upper margins. The most important constituent of the spermatic cord is the ductus deferens. If the cord is rolled between the index finger and the thumb, the duct can be easily distinguished, at the back of the cord, by the hard whipcord-like feel that it produces.

The subcutaneous inguinal ring of the female is not easily defined, because it is small, and the round ligament of the uterus, which passes through it, is not readily felt in the fat of the pubic region.

After the inguinal region has been examined, carry the index finger backwards, from the anterior superior spine of the ilium, along the iliac crest. The crest is easily felt; indeed, in most cases it is visible for a distance of about 65 mm. (two and a half inches). At the point where it disappears from view a prominent tubercle is developed on its external lip. It is there, at the highest point of the iliac crest which can be seen from the front, that the lateral outline of the trunk joins the ilium. As will be seen later, use is made of this fact in subdividing the abdominal cavity into regions.

In females who have borne children the skin over the lower part of the abdomen is wrinkled and scarred.

Parts to be dissected.—During the dissection of the abdominal wall the following parts will be displayed:—

1. Superficial fascia.
2. Cutaneous vessels and nerves.
3. The external oblique muscle of the abdomen.
4. The internal oblique muscle of the abdomen.
5. The anterior branches of the lower six thoracic nerves and accompanying vessels; the ilio-inguinal and ilio-hypogastric nerves.
6. The transversus abdominis muscle.
7. The rectus and pyramidalis muscles and the sheath of the rectus.
8. The transversalis fascia.
9. The inferior epigastric and deep circumflex iliac arteries.
10. The superior epigastric and musculo-phrenic arteries.

11. The spermatic cord.
12. The inguinal canal.
13. The extra-peritoneal fat.
14. The parietal peritoneum.
15. The obliterated umbilical artery.
16. The urachus.

Dissection.—**Reflection of Skin.**—*Incisions*—(1) Along the middle line of the body from the xiphoid process of the sternum to the symphysis pubis. The knife should be carried round the navel so as to surround it with a circular incision. (2) From the xiphoid process transversely round the thorax, as far back as the knife can be carried. (3) From the symphysis pubis laterally, along the line of the inguinal ligament, to the anterior superior spine of the ilium, and then backwards along the crest of the ilium (Fig. 91).

The large flap of skin thus mapped out must be carefully raised from the subjacent superficial fascia and turned laterally. If the abdominal wall is flaccid, the dissection may be facilitated by inflating the abdomen. Make an incision through the umbilicus, large enough to admit the nozzle of the bellows or an injection-pipe fixed to a bicycle-pump, and, when the walls are quite tense, secure the opening with twine, which should previously be sewn through the skin round the lips of the incision.

Panniculus Adiposus (Superficial Fascia).—The superficial fascia, laid bare by the reflection of the skin, presents the same appearance, and possesses the same general characters, as in other localities. Above, it is thin and weak, and is directly continuous with the corresponding fascia over the thorax; below, it becomes more strongly marked, and acquires a greater density. Towards the lower part of the abdomen the superficial fascia develops special characters; it consists of two layers—a fatty superficial stratum called *Camper's fascia*, and a deep membranous stratum termed *Scarpa's fascia.*

There is another point, however, in which the superficial fascia differs somewhat from the same fascia in other parts of the body. It is more elastic, the increased elasticity being due to the augmentation of the elastic fibres in its deeper membranous part. Over the lower part of the linea alba the elastic tissue is collected in the form of a distinct band, which descends, in front of the symphysis pubis, and becomes connected with the suspensory ligament of the penis. A reference to comparative anatomy gives interest to this fact. The elastic band in the human subject is the rudimentary representative of a continuous and distinct layer of yellow elastic tissue (*the abdominal tunic*), which is present in the horse and other quadrupeds in which the weight of the viscera is sustained chiefly by the abdominal wall.

As the two layers of the superficial fascia descend from

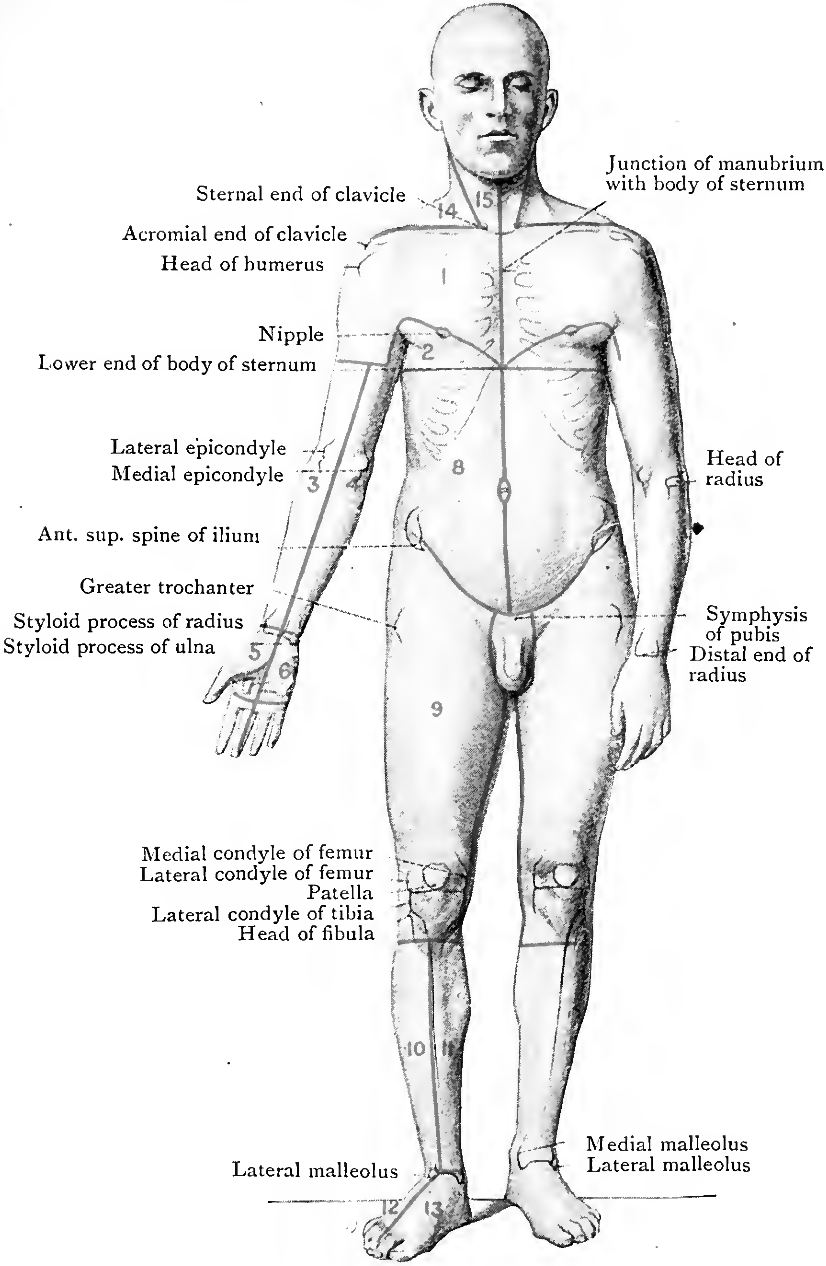

FIG. 91.—Surface view, with Incisions and Bony Points.

the front of the abdomen, the fatty layer of Camper passes over the inguinal ligament and becomes directly continuous

with the fatty superficial fascia on the front of the thigh. The relations of the fascia of Scarpa are very different. In the region of the pubes it is carried continuously downwards over the spermatic cords, the penis and scrotum, into the perineum, where it becomes continuous with the fascia of Colles (see p. 152), which is attached, on each side, to the corresponding body of the pubis. On the lateral side of the spermatic cord, in the region of the groin, Scarpa's fascia ends, immediately distal to the inguinal ligament, by blending with the fascia lata of the thigh.

Dissection.—The connections of the fascia of Scarpa are so important that it is necessary to undertake a special dissection, in order that they may be demonstrated. As this dissection encroaches somewhat upon the region of the thigh, it must be done in conjunction with the dissector of the lower extremity. A transverse incision should be made through the entire thickness of the superficial fascia on the front of the abdomen from the anterior superior spine of the ilium to the median line of the abdomen. When the inferior edge of the divided fascia is raised the two layers can be easily distinguished. Insinuate the fingers between the fascia of Scarpa and the subjacent pearly-looking tendon of the external oblique muscle. Little resistance will be met, as the fascia of Scarpa is bound down to the deeper structures only by some lax areolar tissue. As the superficial fascia is raised from the aponeurosis of the external oblique, the anterior cutaneous branch of the ilio-hypogastric nerve will be seen piercing the aponeurosis and entering the deep surface of the superficial fascia, a little way above the subcutaneous inguinal ring. The fingers can be readily passed downwards behind the fascia of Scarpa as far as the inguinal ligament. There it will be found that they can force their way no farther. The passage of the hand into the thigh is barred by the blending of the fascia of Scarpa with the fascia lata of the thigh. At that level the fascia of Scarpa ceases to exist ; it loses its identity by becoming fused with the deep fascia of the thigh along the line of, and immediately distal to, the inguinal ligament. Towards the pubes the finger can be pushed downwards behind the fascia of Scarpa and along the spermatic cord into the perineum. No barrier opposes the passage of the finger in that direction. The continuity of the fascia of Scarpa and the fascia of Colles is thus demonstrated.

If the dissector now recalls the fact that, in the urethral triangle of the perineum, the fascia of Colles is attached laterally to the margins of the pubic arch and to the anterior surfaces of the bodies of the pubic bones, and posteriorly to the base of the urogenital diaphragm, whilst above the level of the pubic crests it is continuous with the fascia of Scarpa on the front of the abdominal wall, he will have little difficulty in understanding the course which urine takes when extrava-

sated from a rupture of the urethra below the urog nital diaphragm. The effused fluid is directed upwards into the scrotum over the penis, and along the spermatic cords to the

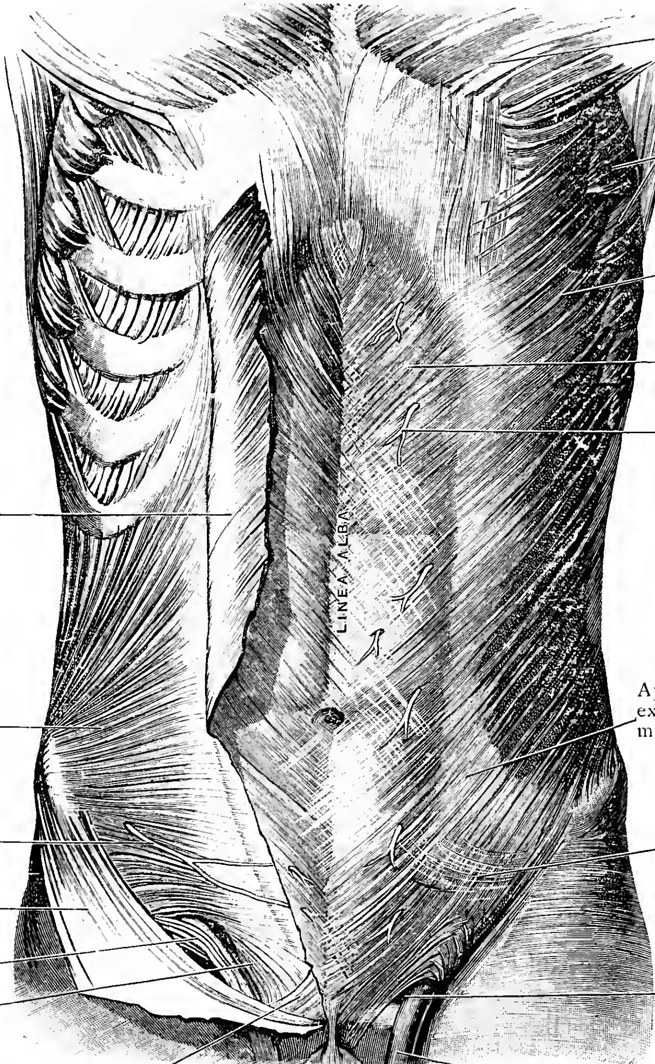

FIG. 92.—Dissection of Anterior Wall of the Abdomen.
The obliquus externus abdominis has been reflected on the right side.

front of the abdomen. From the abdomen it cannot pass downwards to the front of the thighs, owing to the attachment of Scarpa's fascia to the fascia lata. Unless vent be given

to it by early and free incisions, it will continue to ascend over the abdomen between the superficial and the deep fascia.

Nervi Cutanei.—The cutaneous nerves of the anterior and lateral walls of the abdomen are arranged, in an *anterior* and a *lateral series*, on the same plan as the cutaneous nerves of the thorax (p. 5).

Anterior series.	1. Anterior cutaneous nerves. 2. Anterior cutaneous branch of the ilio-hypogastric nerve. 3. The ilio-inguinal nerve.
Lateral series.	1. Lateral cutaneous nerves. 2. Lateral cutaneous branch of the last thoracic nerve. 3. Lateral cutaneous branch of ilio-hypogastric nerve.

The *anterior cutaneous nerves* are the small terminal twigs of the lower five or six thoracic nerves. They pierce the aponeurotic sheath of the rectus muscle at variable points, some close to the median line and others a little distance from it. After entering the superficial fascia they run for a short distance laterally.

Dissection.—To display the anterior cutaneous nerves divide the superficial fascia along the middle line, and reflect it cautiously towards each side. Small arteries accompany the nerves, and serve as guides to their positions.

The *anterior cutaneous branch* of the ilio-hypogastric lies in series with the other anterior cutaneous nerves. When the superficial fascia was dissected it was seen piercing the aponeurosis of the external oblique a short distance above the subcutaneous inguinal ring.

The *ilio-inguinal nerve* passes out through the subcutaneous inguinal ring, and is distributed to the integument of the scrotum, or the labium majus, and the medial aspect of the thigh.

Dissection.—To display the lateral cutaneous nerves cut through the superficial fascia, along the posterior axillary line, from the upper part of the abdominal wall to the iliac crest; then reflect the anterior part of the divided fascia forwards and medially and secure the nerves as they emerge from between the digitations of the external oblique muscle. Each nerve divides into an anterior and a posterior branch. The anterior branches give twigs to the external oblique, and may be followed to the linea semilunaris. The posterior branches should be followed backwards over the lateral border of the latissimus dorsi.

The *lateral cutaneous nerves* are branches of the lower six

thoracic nerves. They become superficial between the digitations of the external oblique muscle, and then each divides into an anterior and posterior division. The *posterior divisions* are small, and are directed backwards over the latissimus dorsi. The *anterior divisions* supply the external oblique muscle and then run forwards, and a careful dissector may trace them as far as the lateral margin of the rectus abdominis.

The *lateral cutaneous branch of the last thoracic nerve* differs from the other members of the series. It does not divide into an anterior and a posterior division, but descends to supply the integument over the gluteal region. It pierces the external oblique muscle, in a line with the other lateral nerves, and is then directed downwards over the crest of the ilium. It crosses the iliac crest from 25 to 50 mm. (one to two inches) behind the anterior superior spine.

The *lateral branch of the ilio-hypogastric nerve* also is distributed to the skin of the gluteal region. It pierces the external oblique immediately above the iliac crest, which it crosses usually opposite the tubercle which projects from the external lip of the crest, about 60 to 65 mm. (about two and a half inches) behind the anterior superior spine of the ilium.

Arteriæ Cutaneæ.—Some of the cutaneous arteries accompany the cutaneous nerves. Those which are associated with the lateral cutaneous nerves are branches of the *aortic intercostal arteries*, whilst those in relation to the anterior cutaneous nerves are derived from the *superior* and *inferior epigastric arteries.*

In addition *three* small branches of the femoral artery ramify in the superficial fascia of the groin.

These are—

1. The superficial external pudendal.
2. The superficial epigastric.
3. The superficial circumflex iliac.

They take origin in the thigh, a short distance distal to the inguinal ligament, and, after piercing the cribriform fascia or the fascia lata, diverge from each other in the superficial fascia.

Arteria Pudenda Externa Superficialis.—The superficial external pudendal artery is directed medially, over the spermatic cord. It gives branches to the skin of the scrotum and inferior surface of the penis.

Arteria Circumflexa Ilium Superficialis.—The superficial circumflex iliac artery passes laterally and upwards, along the line of the inguinal ligament (Pouparti), and ends in the skin in the neighbourhood of the anterior superior spine of the ilium.

Arteria Epigastrica Superficialis.—The superficial epigastric artery takes a course upwards and medially, and, after crossing the inguinal ligament, it ramifies in the superficial fascia over the inferior part of the abdomen. Its branches extend as high as the level of the umbilicus.

The small *veins* which accompany these arteries open into the great saphenous vein.

Muscles of the Abdominal Wall.—The abdominal wall is formed anteriorly and laterally by *five pairs of muscles*, and by the aponeuroses which constitute their tendons. *Anteriorly* are the two recti muscles and the two pyramidales muscles. The recti are placed parallel to the middle line, and extend vertically from the pubic bones to the lower margin of the thorax. *On each side* three fleshy and aponeurotic strata are met with. From the surface towards the abdominal cavity they are (1)—the external oblique muscle; (2) the internal oblique muscle; (3) the transversus abdominis muscle. The direction taken by the muscular fibres which compose each of the layers is different. The external oblique corresponds in direction with the external intercostal muscles; the fibres proceed obliquely downwards, forwards, and medially. The internal oblique resembles the internal intercostal muscles in the direction of its fibres; they are directed upwards, medially, and forwards; thus the fibres of the two oblique muscles cross each other like the limbs of the letter X. Lastly, the fibres composing the transversus abdominis muscle pursue a horizontal course.

The difference of direction of the fibres which compose the three strata is a source of strength to the part of the abdominal wall which they form, and the arrangement offers a strong barrier to the protrusion of any of the abdominal contents. The two oblique muscles and the transversus are prolonged to the middle line in the form of aponeuroses. The union of the aponeuroses of the opposite sides forms the *linea alba*—a strong band which extends, in the median line, from the symphysis pubis to the xiphoid process.

Dissection.—Remove the superficial fascia from the front of

the abdomen and clean the aponeurosis of the external oblique muscle. Near the thorax the aponeurosis of the external oblique is very thin, and it is liable to injury, unless the dissection is performed with care. Proceed cautiously also at the lower part of the abdomen, above the medial end of the inguinal ligament. There the aponeurosis is pierced by the spermatic cord in the male, and by the round ligament of the uterus in the female. The lips of the opening thus formed are prolonged downwards upon the cord, or the ligament, in the form of a thin membrane called the *external spermatic fascia*. In defining this, the blade of the knife must not be used. Work entirely with the handle.

Next clean the muscular part of the external oblique. It may be cleaned either in the ordinary way by cutting through the thin deep fascia which covers the muscle along the line of the fibres, and then separating the fascia from the muscle by sweeping the knife forwards and backwards, along the surface of the muscle, parallel with the fibres, or, and in many cases more conveniently, by incising the fascia along a line at right angles to the fibres, over the posterior part of the muscle, and afterwards sweeping the knife across the surface of the muscle at right angles to the fibres as the fascia is reflected. At the anterior part of the muscle the deep fascia blends with the aponeurosis of insertion, which must not be injured. Finish the cleaning of the muscle by carefully defining the digitations of origin from the lower eight ribs.

FIG. 93.—Crest of the Ilium as seen from above (semi-diagrammatic), with Attachments of Muscles mapped out.

M. Obliquus Externus Abdominis.—The external oblique muscle arises, by *eight* pointed processes or digitations, from the outer surfaces and lower borders of the lower eight ribs (Vol. I. p. 45). The *upper three* digitations interdigitate with the digitations of the serratus anterior, and the latissimus dorsi interdigitates with the *lower four*. From their origins the fibres proceed downwards and forwards, with varying degrees of obliquity. The *posterior fibres* have a nearly vertical direction, and are inserted into the anterior half of the external lip of the crest of the ilium. The *superior fibres* are almost horizontal, and the *middle fibres* are directed obliquely downwards and forwards. All the superior and middle fibres end in a strong aponeurosis called the *aponeurosis of the external oblique*.

Superiorly, where the aponeurosis of the external oblique is very thin, it passes medially to be attached to the xiphoid process. It is from that part of the aponeurosis that the pectoralis major derives fibres of origin. *Inferiorly* the aponeurosis is folded upon itself to form the inguinal ligament, which is attached laterally and superiorly to the anterior superior spine of the ilium, and medially and inferiorly to the tubercle of the pubis. *Between the upper and lower attachments* the aponeurosis lies in front of the rectus, taking part in the

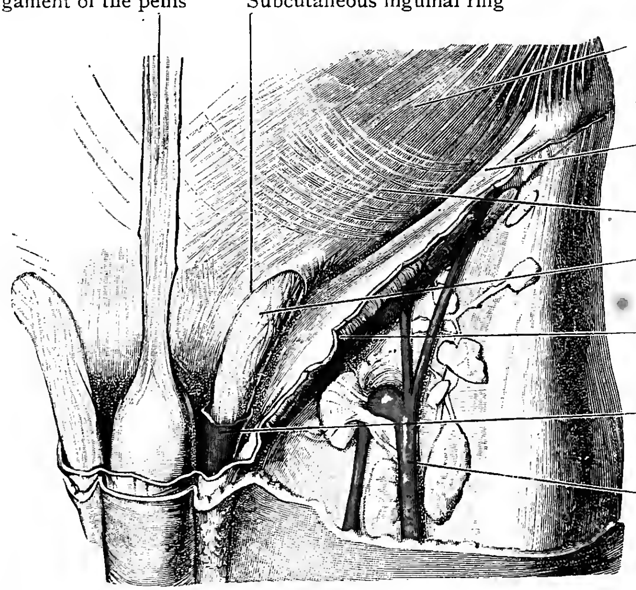

FIG. 94.—Dissection of the Subcutaneous Inguinal Ring and the parts in its vicinity.

formation of its sheath, and it is inserted into the linea alba and into the front of the os pubis.

The aponeurosis is broadest and strongest inferiorly; it is narrowest about the level of the umbilicus, and it widens somewhat again towards the ribs. Superiorly it is so thin that the fibres of the rectus muscle shine through it.

Annulus Inguinalis Subcutaneus (O.T. **External Abdominal Ring**) (Figs. 94 and 95).—In the male, the aponeurosis of the external oblique is pierced, immediately above the pubis, by the spermatic cord; in the female, it is pierced, at the same point and in the same manner, by the round ligament of the

uterus. The aperture which is thus formed receives the name of the *subcutaneous inguinal ring*. At the present stage of the dissection the opening is not visible, because a thin fascial covering, the *external spermatic fascia*, is carried downwards from its lips upon the spermatic cord, or upon the round ligament of the uterus. When the cord is raised and rendered

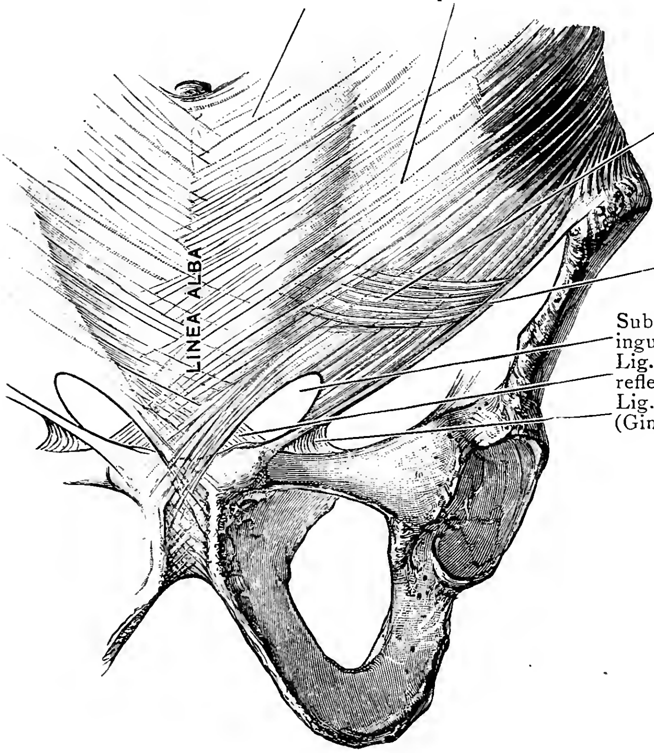

FIG. 95.—Dissection to show the connections of the inferior part of the Aponeurosis of the External Oblique Muscle.

tense, it is obvious that the covering invests it completely, and is somewhat funnel-shaped—wide above, but closing upon the cord as it is traced downwards.

Dissection.—**With the point of the knife divide the external spermatic fascia around the cord, and then, with the handle, define the margins of the subcutaneous inguinal ring.**

When the definition is completed the dissector will note that the term "ring," as applied to the opening, is apt to convey to the mind an erroneous impression. It is not

circular, but triangular, in shape. The long axis of the opening is very oblique, the base of the triangle being formed by the crest of the pubis, whilst the apex is directed laterally and slightly upwards.

The subcutaneous inguinal ring, therefore, is merely a small gap or interval left between that portion of the aponeurosis of the external oblique muscle which forms the inguinal ligament, and that portion which is inserted into the front of the pubic bone. The margins of the aperture are termed *the crura of the ring*. The *superior crus* is flat and broad, and is attached to the body of the pubis. Some of its fibres cross the median plane, decussate with the corresponding fibres of the other side, and are inserted into the front of the opposite pubic bone. The *inferior crus* is merely the medial end of the inguinal ligament. It is, therefore, thick and strong, and is fixed to the pubic tubercle. The spermatic cord, as it issues from the subcutaneous inguinal ring, rests upon the inferior crus.

The *size* of the subcutaneous inguinal ring is very variable. In the male, the average length may be said to be 25 mm. (one inch), and the breadth about 12.5 mm. (half an inch). In the female, it is much smaller; and the round ligament of the uterus, which passes through it, ends in the superficial fascia of the groin.

On a close inspection of the lower part of the external oblique aponeurosis, the student will see a number of cross fibres arching over its surface. They are called the *intercrural fibres*, and in some cases they are very strongly marked. They begin at the inguinal ligament, close to the iliac spine, and curve upwards and medially, upon the aponeurosis, above the subcutaneous inguinal ring. The function of the intercrural fibres is very evident, and the term "*intercrural*" is derived from the part which they play. They bind together the two crura of the ring, and prevent their further separation. There is a direct continuity between the intercrural fibres and the external spermatic fascia which clothes the spermatic cord.

Dissection.—**Reflection of the Obliquus Externus.**—Between the last rib and the crest of the ilium the posterior border of the external oblique muscle is free, and as this border will be examined when the body is placed on its face it must not be disturbed at present. Begin by detaching the upper six serrations of the muscle from the ribs; from the interval between the sixth and

seventh serrations carry an incision downwards, through the fibres of the muscle, to the posterior border of the tubercle on the external lip of the iliac crest. Raise the anterior portion of the muscle from the surface of the subjacent internal oblique and turn it medially, dividing the fleshy fibres inserted into the iliac crest close to the bone. Next, divide the aponeurosis horizontally, in a line leading from the anterior superior spine to the lateral border of the rectus. The greater part of the muscular and aponeurotic portion of the external oblique can now be thrown medially. The dissector must proceed with care on approaching the lateral border of the rectus, because a little beyond that border the anterior lamella of the aponeurosis of the internal oblique fuses with the deep surface of the aponeurosis of the external oblique. Define the line of union, and notice that it does not extend beyond the lower margin of the thorax. Above that the rectus is covered merely by the aponeurosis of the external oblique; its lateral margin in that locality is bare, and the hand can be freely passed between the rectus muscle and the costal cartilages.

On the *left side* of the body, the parts below the horizontal line drawn from the anterior superior iliac spine to the lateral border of the rectus, along which the aponeurosis of the external oblique muscle has been divided, should be preserved intact for the special study of the structures associated with inguinal hernia. On the *right side* of the body, divide the lower part of the aponeurosis along the lateral border of the rectus down to the pubis. The incision should pass to the medial side of the superior crus of the subcutaneous inguinal ring, so that that opening may be preserved. The triangular flap of aponeurosis must now be thrown downwards and laterally. By this proceeding the inguinal ligament, the internal oblique muscle and the cremaster muscle are displayed for study.

Ligamentum Inguinale (Pouparti).—The inguinal ligament is merely the thickened lower border of the aponeurosis of the external oblique folded backwards upon itself. It thus presents a rounded surface towards the thigh and a grooved surface towards the abdomen. The manner in which it is attached by its lateral and medial extremities deserves the close study of the dissector. *Laterally* it is fixed to the anterior superior spine of the ilium; *medially* it has a double attachment, viz.—(1) to the pubic tubercle, which may be considered as its attachment proper; (2) through the medium of the lacunar ligament (*Gimbernat's*) to the ilio-pectineal line.

The inguinal ligament does not pursue a straight course between its iliac and pubic attachments. It describes a curve, the convexity of which is directed downwards and laterally towards the thigh. By its inferior border it gives attachment to the fascia lata. When that is divided, the inguinal ligament at once loses its curved direction.

Ligamentum Lacunare (Gimbernati) (Fig. 95).—The lacunar ligament is a triangular process of aponeurotic membrane. Raise the spermatic cord, or the round ligament of the uterus, place the finger behind the medial end of the inguinal ligament, and press downwards. The structure upon which the finger rests is the lacunar ligament, and the student should note that it offers a barrier to the passage of the finger into the thigh. With the handle of the knife, its shape and connections can be easily defined. Its *apex* is fixed to the pubic tubercle; by *one margin* it is attached to the medial part of the inguinal ligament; by its *other margin* it is inserted for the distance of an inch into the ilio-pectineal line. Its *base* is sharp, crescentic, and free, and is directed laterally towards the femoral sheath. The dissector should thoroughly realise that the lacunar ligament is not an independent structure. It is merely the medial part of the folded-back margin of the inguinal ligament which, in the vicinity of the pubic tubercle, obtains an attachment to bone.

The lacunar ligament occupies an oblique plane, its lower or femoral surface looking distally and slightly forwards and laterally, whilst its upper or abdominal surface looks upwards and slightly backwards and medially. It is of importance that the student should note the precise relation which this ligament bears to the spermatic cord. Taken in conjunction with the inguinal ligament and the aponeurosis of the external oblique, it forms a groove in which the cord lies.

Ligamentum Inguinale Reflexum (O.T. Triangular Fascia) (Fig. 95).—The reflex inguinal ligament is a small triangular sheet of fibres which springs from the crest of the pubic bone and the medial end of the ilio-pectineal line. It runs upwards and medially, under cover of the superior crus of the subcutaneous inguinal ring, and joins the linea alba. If the fibres which compose it are followed through the linea alba, they will be found to be continuous with the fibres of the aponeurosis of the external oblique muscle of the opposite side. It must, therefore, be considered as an additional insertion of that muscle. It is, frequently, so poorly developed that its true relations and connections are demonstrated with difficulty, if indeed they are capable of demonstration at all (Figs. 96, 98).

Dissection.—**The internal oblique muscle must now be cleaned. Towards its lower part it is pierced by certain nerves, and they**

must be preserved. Close to the iliac crest the *lateral branches* of the ilio-hypogastric and last thoracic nerves emerge from the midst of its fleshy fibres, whilst anteriorly it is pierced by the *anterior branch* of the ilio-hypogastric and by the *ilio-inguinal nerve.* The anterior branch of the ilio-hypogastric nerve appears near the anterior superior iliac spine, and then proceeds medially under cover of the external oblique aponeurosis, which it pierces near the lateral border of the sheath of the rectus abdominis. The ilio-inguinal nerve perforates the internal oblique a short distance medial to the hypogastric nerve and at a lower level. It becomes superficial by passing through the subcutaneous inguinal ring.

Care must be taken when defining the inferior margin of the muscle to preserve its relations to the spermatic cord, and not to injure the muscular fasciculi which it gives to the cremaster muscle.

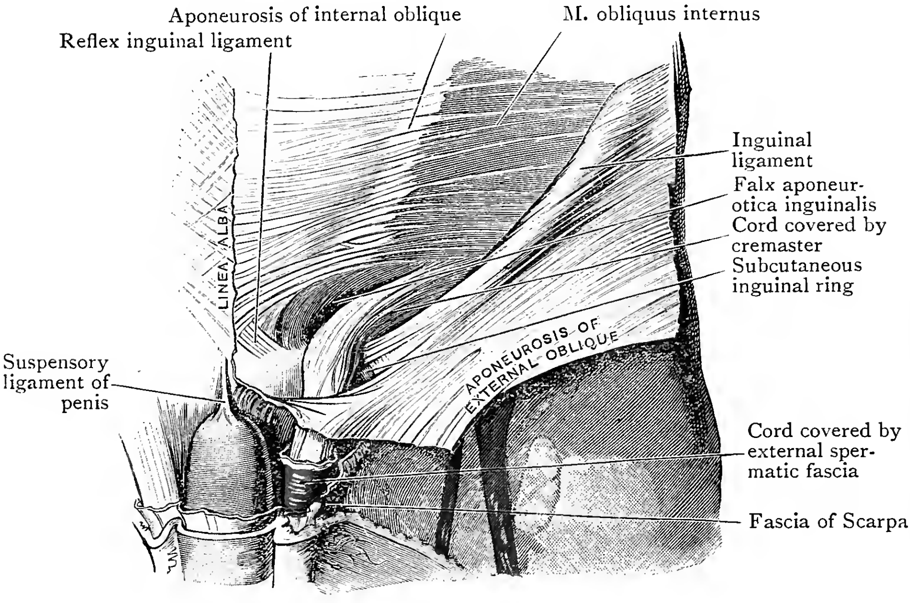

FIG. 96.—Dissection of the Inguinal Region.
The aponeurosis of the external oblique is turned down.

M. Obliquus Internus Abdominis (Fig. 92).—The internal oblique muscle *arises*—(1) from the lateral half of the abdominal grooved surface of the inguinal ligament; (2) from the intermediate line of the anterior two-thirds of the iliac crest; (3) from the lumbar fascia. The muscular fibres radiate from their origins, but their general direction is from below upwards and medially. The *posterior fibres* ascend, and are inserted into the lower borders of the cartilages of the lower four ribs. Those fibres occupy the same plane as the

internal intercostal muscles—indeed, they will be observed to be directly continuous with the fibres of the internal intercostal muscles of the lower two spaces. The *lowest fibres*, those springing from the inguinal ligament, arch downwards and medially, and join with the lowest fibres of the transversus in a flat tendon, called the *falx inguinalis* (O.T. *conjoined tendon*), which is inserted into the pubic crest, and into the ilio-pectineal line, for fully 12.5 mm. (half an inch) of its extent, behind the lacunar ligament and the reflex inguinal ligament (Figs. 101 and 97). The *middle fibres* pass upwards and medially, and end in a strong aponeurosis, which extends from the inferior margin of the thorax to the pubis. By that aponeurosis they gain insertion into the inferior borders of the cartilages of the seventh and eighth ribs and the xiphoid process, and into the linea alba throughout its entire length. The manner in which the aponeurosis reaches the middle line requires special description.

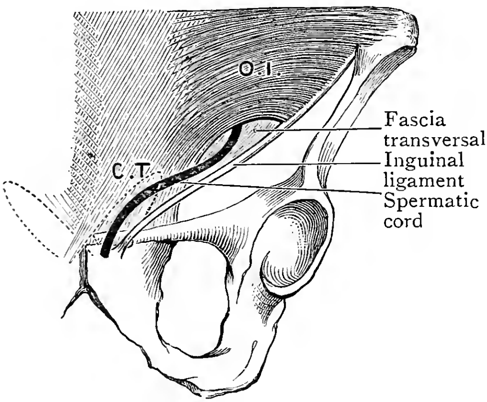

FIG. 97.—Diagram to illustrate the relation of the lower border of the Internal Oblique Muscle to the Cord, the Falx Inguinalis, and the Inguinal Canal.

O.I. Internal oblique muscle.
C.T. Falx Inguinalis.

The position of the subcutaneous inguinal ring is indicated by a dotted outline.

At the lateral margin of the rectus muscle the aponeurosis of the internal oblique splits into two layers—a superficial and a deep. The *superficial layer of the aponeurosis* passes in front of the rectus, and has already been seen to fuse with the aponeurosis of the external oblique muscle. The *deep layer* is carried medially behind the rectus, and becomes incorporated with the subjacent aponeurosis of the transversus muscle. But this arrangement does not hold good lower down than a point about midway between the umbilicus and the pubis. Below that point the aponeurosis does not split, but passes entirely in front of the rectus to join the aponeurosis of the external oblique.

It is important to mark exactly the relation which the inferior part of the muscle bears to the spermatic cord. At first the cord lies behind the fleshy fibres, but it soon emerges, clothed by the cremaster muscle, and, as it is continued downwards and medially to the subcutaneous inguinal ring, it lies in front of the falx aponeurotica inguinalis (O.T. conjoined tendon). Especially note the position of the falx inguinalis in relation to the subcutaneous inguinal ring. It lies immediately behind it, and gives strength to that otherwise weak point in the abdominal parietes.

M. Cremaster.—The cremaster muscle supports the testis and spermatic cord, and is consequently peculiar to the male. It *arises* from the medial part of the inguinal ligament, and it derives fibres also from the inferior border of the internal oblique (rarely from the inferior border of the transversus abdominis muscle). The fleshy fibres descend upon the lateral and anterior aspects of the cord in the form of loops, the concavities of which are directed upwards. The depth to which the loops descend varies. Some reach the tunica vaginalis of the testis, and the scrotum should now be opened up, on the right side, in order that they may be traced downwards to their terminations; the majority of the fibres, however, do not reach so far down, some going no farther than the subcutaneous inguinal ring. Upon the posterior aspect of the cord the loops are directed upwards, and some, reaching the os pubis, obtain a tendinous insertion into its tubercle and crest.

It will be noticed that the cremasteric fleshy loops do not form a complete investment for the cord and testis. The intervals between the fasciculi are occupied by areolar tissue, and the combination of muscular and areolar tissue is sometimes termed the *cremasteric fascia*.

Dissection.—Reflection of Internal Oblique.—On the *right* side of the body the entire muscle may be reflected, but on the left side preserve the inferior portion of it (*i.e.*, that part which is still covered by the aponeurosis of the external oblique) *in situ*. Begin below by dividing the muscular fibres along the crest of the ilium. The depth to which the knife should be carried is indicated by the dense areolar tissue which lies between the internal oblique and the subjacent transversus muscle. An ascending branch from the deep circumflex iliac artery will also serve as a guide. That vessel emerges from the fibres of the transversus muscle and then runs upwards upon its surface, close to the anterior part of the iliac crest. Although the vessel

has not attained the dignity of a name, it is a very constant branch. On the right side the fibres springing from the inguinal ligament should also be severed, but on the left side carry the knife horizontally, from the anterior superior spine of the ilium to the lateral margin of the rectus. Now turn to the upper part of the muscle, and make an incision through it, along the lower margin of the thorax, from the lateral border of the rectus to the last rib. Lastly, carry the knife downwards, from the tip of the last rib to the crest of the ilium.

The muscle freed in this manner can be reflected medially towards the lateral border of the rectus, but the dissector must proceed with caution, because he has reached the plane of the main trunks of the nerves of the abdominal wall and the arteries which accompany them. The nerves and vessels pass medially between the internal oblique and the transverse muscles, and, as the former muscle is raised, they are apt to adhere to its deep surface and will be cut if proper care is not exercised.

In all probability the student will experience considerable difficulty in separating the lowest part of the internal oblique from the corresponding portion of the transversus abdominis, for the lower parts of the two muscles are always closely connected, and in some cases they are partially blended.

On the right side the *cremaster muscle* should also be reflected from the spermatic cord. That can best be done by making a longitudinal incision through its fibres. Entering the deep surface of the cremaster are a small *branch of the inferior epigastric artery* and the *external spermatic nerve* (*a branch of the genito-femoral*). They constitute its vascular and nervous supply, and must, if possible, be secured. Now clean the transversus abdominis muscle, and the vessels and nerves which lie upon it.

Nerves of the Abdominal Wall.—The dissector will find the following nerves running forwards upon the transversus abdominis muscle :—

1. The anterior branches of the lower six thoracic nerves.
2. The ilio-hypogastric nerve. } From the anterior ramus of the first
3. The ilio-inguinal nerve. } lumbar nerve.

The *anterior branches of the lower six thoracic nerves* enter the abdominal wall at the margin of the costal arch, where they insinuate themselves between the internal oblique and the transversus abdominis muscles. Then they run to the lateral border of the rectus muscle, where they disappear by piercing the posterior lamella of the internal oblique aponeurosis, and passing within the sheath of the rectus. In a subsequent dissection they will be seen sinking into the substance of the rectus, supplying it with twigs, and then turning forwards to pierce the front of the sheath. They end on the front of the abdomen as the *anterior cutaneous nerves*. They supply offsets to the internal oblique and also

to the transversus abdominis. Minute arteries accompany the nerves.

The *anterior branch of the last thoracic nerve* also supplies the oblique and transverse muscles, and, in addition, it gives a branch to the pyramidalis muscle.

The lateral branches of the lower thoracic nerves have already been exposed and studied (p. 204).

The *ilio-hypogastric* and *ilio-inguinal* are the lowest two nerves of the series. They are directed forwards between the internal oblique and the transversus, close to the crest of the ilium.

The ilio-hypogastric is the higher of the two. It gives off an *iliac* or *lateral cutaneous branch*, which pierces the two oblique muscles, and then crosses the crest of the ilium to reach the skin of the gluteal region. The *anterior portion* of the nerve perforates the internal oblique, a short distance in front of the anterior superior spine of the ilium, and then runs forwards towards the linea alba. It does not enter the sheath of the rectus, but becomes superficial by piercing the aponeurosis of the external oblique above the subcutaneous inguinal ring.

The *ilio-inguinal nerve* gives off no lateral branch. It pierces the internal oblique, to which it gives branches, a short distance above the inguinal ligament, and it becomes superficial by passing through the subcutaneous inguinal ring.

M. Transversus Abdominis.—The transversus abdominis muscle is the deepest of the three muscular strata which enter into the formation of the wall of the abdomen. It has a threefold origin, viz.—from the pelvis, from the vertebral column, and from the costal cartilages. By its *pelvic origin* it is attached to the lateral third of the inguinal ligament and to the anterior two-thirds of the internal lip of the crest of the ilium; by its *costal origin* it arises from the inner surfaces of the costal cartilages of the lower six ribs, by a series of slips or digitations which interdigitate with the slips of origin of the daphragm; by its *vertebral origin* it is attached, through the medium of the lumbo-dorsal fascia, to the spinous processes, and the tips and roots of the transverse processes, of the lumbar vertebræ (Fig. 98). Indeed, the lumbo-dorsal fascia constitutes the posterior aponeurosis of the muscle. The manner in which the lumbo-dorsal fascia is attached to the

vertebræ needs further explanation. As it approaches the vertebral column it splits into three layers or lamellæ; the *posterior lamella* is attached to the tips of the spinous processes, the *anterior lamella* to the roots of the transverse processes, and the *middle lamella* to the tips and adjacent sides of the transverse processes. Two compartments are thus formed; the posterior of the two is occupied by the sacro-spinalis (O.T. erector spinæ), whilst the anterior contains the quadratus lumborum. The points referred to cannot be demonstrated at this stage of the dissection, but a reference to Fig. 98 will help the student to understand the arrangement.

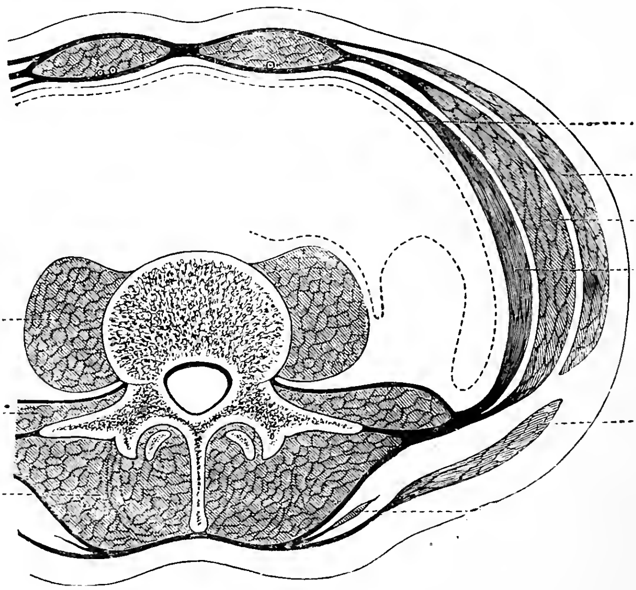

FIG. 98.—Lumbo-dorsal fascia and sheath of Rectus abdominis. The dotted line represents the Peritoneum.

Anteriorly, the fibres of the transversus abdominis muscle end in a strong aponeurosis, which is inserted into the linea alba, the pubic crest, and the ilio-pectineal line. Towards the aponeurosis the fleshy fibres for the most part run in a transverse direction. The lower fibres, however, take a curved course downwards and medially, so that the muscle presents an arched lower margin.

The dissector has already seen that the lowest portions of the aponeuroses of the internal oblique and the transverse muscles blend to form the *falx inguinalis* (O.T. *conjoined tendon*). It is through the medium of the falx inguinalis that the

transversus abdominis gains its insertion into the pubic crest and into the ilio-pectineal line. The aponeurosis of the

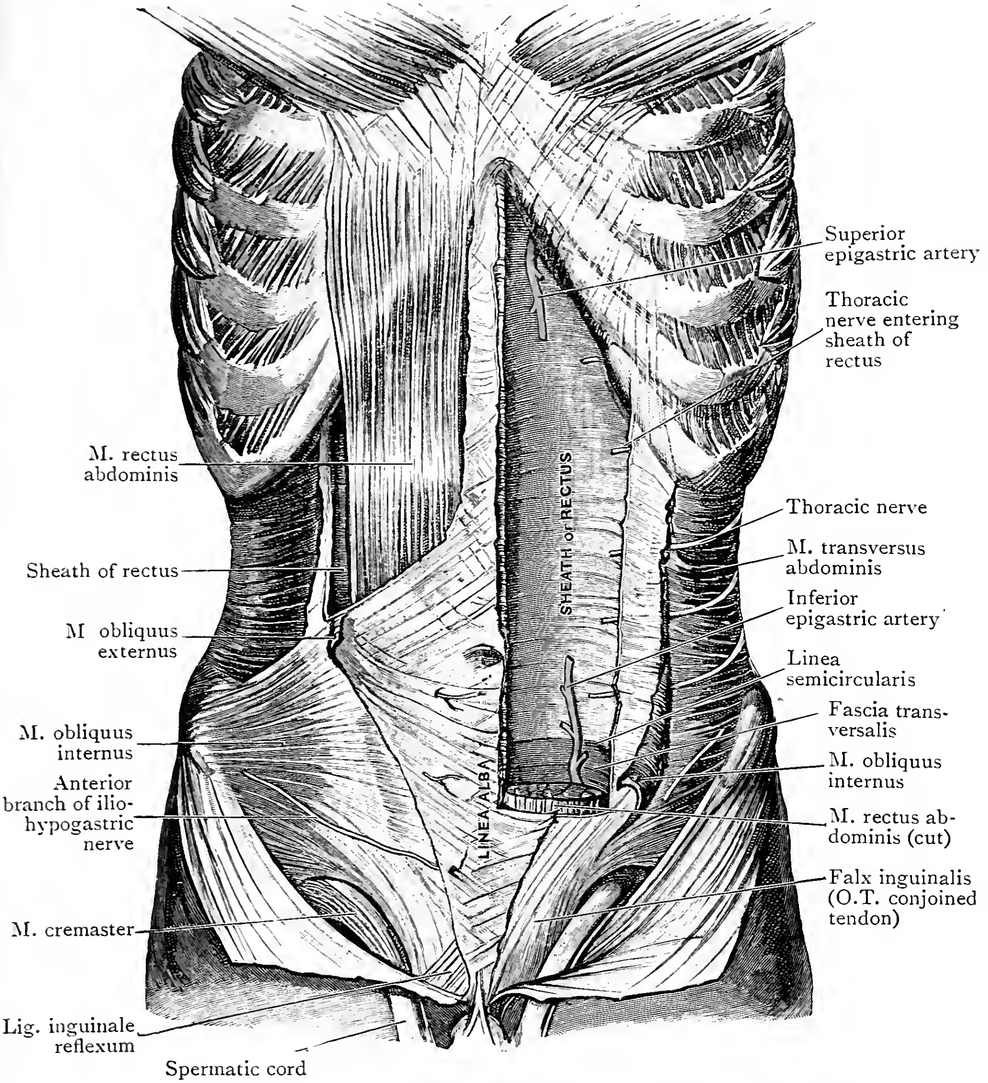

FIG. 99.—Deep dissection of the Anterior Wall of the Abdomen. On the *left side* the external oblique and the internal oblique have for the most part been removed, the sheath of the rectus opened, and the greater part of the contained muscle removed. On the *right side* the external oblique, the upper part of the internal oblique, and the upper part of the anterior wall of the sheath of the rectus have been removed.

transversus abdominis constitutes the greater portion of the falx inguinalis—indeed, whereas the internal oblique aponeurosis has an attachment to the ilio-pectineal line of little

more than 12.5 mm. (half an inch), the aponeurosis of the transversalis is fixed to fully one inch of that line.

Above the level of the falx inguinalis the aponeurosis of the transversus is inserted into the linea alba, but in passing medially to that insertion it presents two different relations to the rectus muscle. Down to a point midway between the umbilicus and pubes it passes *behind* the rectus, and blends with the posterior lamella of the aponeurosis of the internal oblique. Below that point it passes *in front of* the rectus, and blends with the aponeuroses of the internal oblique and external oblique.

The two oblique muscles and the transversus are very efficient protectors of the abdominal contents; they contract and become firm and hard when blows or pressure threaten or impinge upon the abdominal wall. They help the other muscles of the abdominal wall to maintain the intra-abdominal pressure by means of which the abdominal viscera are kept in position. They are muscles of expiration, because when they contract they press upon the abdominal viscera, tending to force them towards the thorax, so elevating the diaphragm and reducing the capacity of the thorax. They also play a part in defæcation, for their contraction increases the intra-abdominal pressure and so helps the rectum to evacuate its contents. All three muscles are supplied by the anterior branches of the lower six thoracic nerves, and by the anterior branch of the ilio-hypogastric nerve.

Dissection.—Turn now to the sheath of the rectus abdominis and note that crossing it transversely are three linear thickenings, the *lineæ transversæ*. One lies at the level of the xiphoid process of the sternum, another at the level of the umbilicus, and the third is midway between the other two. Occasionally a fourth transverse linear thickening is present below the umbilicus. Divide the sheath by a vertical incision along the middle line of the muscle, then raise the medial and lateral parts of the divided sheath from the surface of the muscle, reflect the medial part towards its attachment to the linea alba, and the lateral part towards the lateral border of the muscle. Between the lineæ transversæ the sheath can be separated from the muscle with the handle of the scalpel, but at the lineæ transversæ the front of the sheath is blended with tendinous intersections in the muscle, and the edge of the scalpel must be called into play. As the flaps of the sheath are raised the anterior cutaneous nerves must be preserved.

Contents of the Sheath of the Rectus.—Within the sheath of the rectus are the following structures:—

1. The rectus muscle.
2. The pyramidalis muscle.
3. The terminal portions of the anterior branches of the lower six thoracic nerves.
4. The inferior epigastric artery, some of its branches, and venæ comites.
5. The superior epigastric artery, some of its branches, and venæ comites.

Dissection.—The front part of the sheath of rectus abdominis has already been turned aside, now look for the pyramidalis; if it is present it will be found in the lower part of the sheath, in front of the rectus, extending from the front of the os pubis and the ligaments of the symphysis pubis to the lower part of the linea alba; clean it, then detach it from the linea alba, and turn it downwards. As it is reflected secure its nerve of supply. It is a twig of the last thoracic nerve which pierces the rectus and enters the deep surface of the pyramidalis. After the attachments of the pyramidalis have been displayed, raise the lateral border of the rectus with the handle of the scalpel, and secure the terminal parts of the anterior branches of the lower six thoracic nerves as they enter the sheath after piercing the posterior lamella of the aponeurosis of the internal oblique muscle. Note that the nerves are associated with small branches of the superior and inferior epigastric arteries which leave the sheath through the openings by which the nerves enter.

The posterior surface of the rectus muscle, unlike the anterior surface, is not attached to the sheath by lineæ transversæ; therefore it can easily be raised from the posterior part of the sheath and the nerves can be followed into the substance of the muscle. When the facts mentioned have been verified, cut the nerves between the points where they enter the sheath and the points where they enter the muscle, and at the same time cut the small arteries which lie beside the nerves; then divide the rectus abdominis about the middle of its length. Turn the upper part of the divided muscle upwards and secure the superior epigastric artery which descends into the sheath behind the costal cartilages and then enters the muscle, and define the attachments of the muscle to the xiphoid process of the sternum, and the cartilages of the seventh, sixth, and fifth ribs. Throw the lower part of the muscle downwards, secure the inferior epigastric artery as it enters the sheath about midway between the umbilicus and the pubis, then define the inferior attachments of the muscle to the crest of the os pubis and the front of the symphysis pubis.

M. Pyramidalis.—The pyramidalis is a small triangular muscle—not always present—which springs from the front of the pubis and the ligaments of the symphysis, and is inserted into the linea alba. It lies anterior to the lower part of the rectus. It is a tensor of the linea alba and is supplied by the last thoracic nerve.

M. Rectus Abdominis.—The rectus abdominis is a broad band of muscular fibres which stretches between the thorax and the pubes, at the side of the linea alba. Inferiorly, it *arises* by two heads; the lateral and larger of the two is

attached to the pubic crest, whilst the medial and smaller is fixed to the ligaments in front of the symphysis pubis. Towards the thorax the muscle widens and becomes thinner, and its *insertion* is effected by three large slips into the anterior aspect of the costal cartilages of the *fifth*, *sixth*, and *seventh ribs*, and by a smaller slip to the xiphoid process of the sternum.

The rectus muscle is broken up into segments by irregular tendinous intersections—the *inscriptiones tendineæ* or *lineæ transversæ.* They are usually three in number, and are placed, one at the level of the umbilicus, another opposite the xiphoid process, and a third midway between. A fourth intersection is sometimes found below the level of the umbilicus. The tendinous intersections are adherent to the anterior part of the sheath of the rectus; but they have no attachment to the posterior part of the sheath.

The rectus abdominis protects the abdominal contents. It becomes firm and hard when pressure on the front of the abdominal wall threatens or occurs, and by its tonicity it helps to maintain the intra-abdominal pressure. It depresses the ribs to which it is attached and presses upon the abdominal contents. It is, therefore, a muscle of expiration and defæcation, and, as it pulls the front of the thorax downwards towards the symphysis, it is a flexor of the vertebral column. It is supplied by the anterior branches of the lower six thoracic nerves.

Vagina Recti Abdominis (Sheath of the Rectus).—The dissector is now in a position to study the manner in which the sheath of the rectus is formed. An examination of the relations which the aponeuroses of the three flat muscles of the abdomen bear to the rectus will show that the sheath is incomplete, and does not entirely surround the rectus. It is deficient *posteriorly*, both above and below.

From the lower margin of the thorax to a point midway between the umbilicus and pubes it encloses the rectus upon all sides. In that part of its extent the *anterior wall* is formed by the aponeurosis of the external oblique fused with the anterior layer of the aponeurosis of the internal oblique, whilst the *posterior wall* is formed by the posterior layer of the aponeurosis of the internal oblique fused with the aponeurosis of the transversus abdominis (Fig. 98).

Superiorly, the rectus muscle rests directly upon the costal

cartilages, and the sheath is represented merely by the aponeurosis of the external oblique, which covers the muscle anteriorly. *Inferiorly* also, the posterior wall of the sheath is absent, and the rectus rests on the transversalis fascia. There the anterior wall is formed by a blending of all three aponeuroses (Fig. 100).

The lower free margin of the posterior wall of the sheath can be defined with the handle of the knife after the rectus is raised. It frequently presents a sharp lunated edge, the concavity of which is directed downwards towards the pubis. The curved edge is called the *linea semicircularis* (O.T. *semilunar fold of Douglas*). The inferior epigastric artery enters the sheath by passing upwards in front of the linea semicircularis (Fig. 99).

The linea semicircularis is, however, often rendered in-

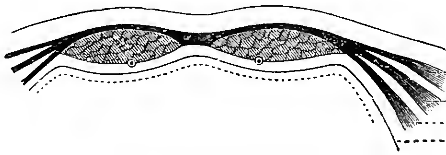

FIG. 100.—Transverse section through the Abdominal Wall a short distance above the Pubes.

distinct by the presence of scattered tendinous bundles crossing behind the lower part of the rectus.

Linea Alba.—The linea alba can now be studied to the best advantage. It is a dense fibrous cord or band which extends perpendicularly between the xiphoid process and the symphysis pubis. It is formed by the union and decussation of the fibres composing the aponeuroses of the two oblique muscles and the transverse muscles of opposite sides. Above the umbilicus it is broad and band-like; whilst below that point it becomes narrow and linear. A close examination will show that it is pierced by several small round openings, for the transmission of blood-vessels, and from some of these the dissector may observe minute fatty masses protruding. A little below its middle is the umbilicus, but the foramen of which the umbilicus is the remains, is completely closed at birth; indeed, in the adult the linea alba is stronger at that point than elsewhere.

Fascia Transversalis.—The transversalis fascia is a thin layer of fascia which is spread out upon the deep surface of the

transversus abdominis muscle. The fascia of one side is directly continuous, behind the sheaths of the recti abdominis, with the fascia of the opposite side, and forms a part of an extensive fascial stratum which lines the entire abdominal wall, and is placed between the abdominal muscles and their

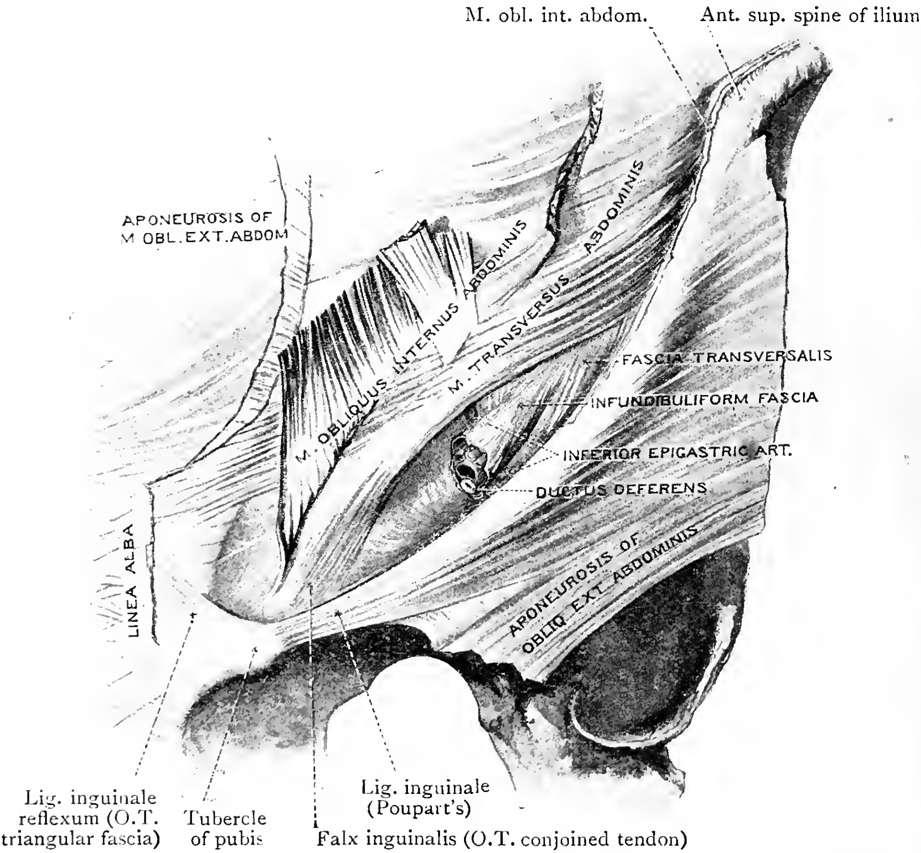

FIG. 101.—Deep dissection of the Inguinal Region. The internal oblique has been reflected to show the whole length of the inguinal canal; and the cord, enclosed within the internal spermatic fascia, is seen cut across.

aponeuroses on the one hand, and the extra-peritoneal fatty tissue on the other.

Traced upwards, the fascia transversalis becomes thin and, at the margin of the thorax, it is directly continuous with the diaphragmatic fascia which covers the lower surface of the diaphragm. In the inguinal region it plays an important part as a constituent of the posterior wall of the inguinal canal.

In the present state of the dissection (on the right side of

the body), a small gap or interval is seen to exist between the arched lower border of the transverse muscle and the inguinal ligament. The membrane which fills up that interval is part of the *transversalis fascia.* At no part of the abdominal wall is the transversalis fascia stronger than in that region, and the accession of strength is obviously for the purpose of compensating for the deficiency in the transverse muscle, which, in that area, does not descend so low as the inguinal ligament. In the area the transversalis fascia has an important relation to the spermatic cord. It is pierced by the cord, but as yet no opening is visible. Take hold of the cord and draw it downwards and medially. The margins of the aperture through which it passes will be observed to be prolonged downwards upon the cord in a funnel-shaped manner, so as to invest it upon all sides with a tube of fascia. The investment, which is thus seen to come directly from the fascia transversalis, is called the *internal spermatic fascia.*

Dissection.—**It is now the object of the dissector to demonstrate the more important attachments of the transversalis fascia. He must, therefore, divide the fibres of the transverse muscle along the lateral part of the inguinal ligament and along the crest of the ilium, and, raising the muscle from the subjacent fascia, throw it upwards. It is not necessary to reflect the entire muscle.**

Attachments of the Fascia Transversalis.—When the fascia is cleaned with the handle of the scalpel, it will be seen to be attached *laterally* to the internal lip of the iliac crest. Along the line of that attachment, which is by no means firm, it becomes continuous with the *fascia iliaca,* which is merely the portion of the same fascial stratum covering the iliacus and psoas muscles in the iliac fossa. Close to the crest of the ilium the fascia transversalis is pierced first by the ascending branch, and then by the deep circumflex iliac artery itself. *Anteriorly,* in the inguinal region, its connections are more complicated, and must be studied at three different points — (1) between the anterior superior spine of the ilium and the femoral artery, where it will be seen to be attached to the inguinal ligament; along that line also it becomes continuous with the fascia iliaca; (2) opposite the femoral vessels, where it is carried distally into the thigh behind the inguinal ligament, to form the anterior part of the femoral sheath (Vol. I., p. 240); (3) medial to the femoral

vessels, where it is attached to the pectineal line or pecten of the superior ramus of the pubis, behind the falx inguinalis (O.T. conjoined tendon), with which it is partially blended.

Annulus Inguinalis Abdominalis (Abdominal Inguinal Ring).—It has been noted that the transversalis fascia is pierced by the spermatic cord. The opening through which it passes is called the *abdominal inguinal ring* (O.T. internal abdominal ring). The margin of the ring is prolonged downwards on the cord as the internal spermatic fascia. It follows, therefore, that the opening can be defined, from the front, only by an artificial dissection, viz.—by dividing the internal spermatic fascia around the cord and pushing it upwards with the handle of the knife. The ring thus defined lies about 12.5 mm. (half an inch) above the inguinal ligament, at a point midway between the symphysis pubis and the anterior superior spine of the ilium. Through the opening the dissector will see the extra-peritoneal fat, upon which the transversalis fascia rests, and, just medial to the opening, the inferior epigastric artery is visible through the fascia, pursuing its oblique course upwards and medially. If the handle of the knife is now introduced into the ring and carried laterally between the fascia and extra-peritoneal fat, the attachments of the fascia to the inguinal ligament and to the iliac crest can be demonstrated.

Canalis Inguinalis (Inguinal Canal).—It has been shown that the spermatic cord, in the male, and the round ligament, in the female, pierce the abdominal wall above the inguinal ligament. The passage which is formed for their transmission receives the name of the *inguinal canal.* The canal is a source of weakness to the abdominal wall; and it is in connection with it that inguinal hernia occurs, and the student will understand, therefore, how necessary it is that he should examine its position and its walls carefully from all points of view.

The *inguinal canal* is a narrow channel of about 38 mm. (one inch and a half) in length. It begins at the abdominal inguinal ring, which may be spoken of as its inlet, and ends at the subcutaneous inguinal ring, which constitutes its outlet. It is, consequently, very oblique, having a direction almost directly medialwards, with a slight inclination downwards and forwards. So much for its length and direction;

its floor, its anterior wall, and its posterior wall have still to be examined.

The *floor* of the lateral and deeper part of the canal is formed by the upper grooved surface of the inguinal ligament. Towards the outlet, however, the floor becomes broader and more definite; there it is formed not only by the inguinal ligament, but also by the lacunar ligament. At that point, as the dissector has previously noted, the cord rests directly upon the abdominal surface of the lacunar ligament. The parts which enter into the formation of the *anterior wall* are—(1) the aponeurosis of the external oblique, throughout the entire extent of the canal; and (2) the lower border of the internal oblique, in the lateral third of the canal. These facts can be readily verified if the structures are restored to their original positions. The parts which compose the *posterior wall* are still *in situ*. Named in order, from the inlet to the outlet, they are—(1) the fascia transversalis; (2) the falx inguinalis; and (3) the ligamentum inguinale reflexum, when that structure is developed (Fig. 102).

But it may be asked, does the transversus abdominis muscle take no part in the formation of the inguinal canal? The student can readily satisfy himself as to that point. He will notice that the arched lower border of the transversus muscle does not descend so low as the lower border of the internal oblique; that, in fact, it stops short immediately above the abdominal inguinal ring. Therefore the transversus abdominis takes no part in the formation of the anterior wall of the canal. The canal is closed superiorly by the approximation of the anterior and posterior walls, above the cord, and by the intervention between the walls of the lower border of the transversus abdominis.

There is still another point to be noted, viz., the relation which the inferior epigastric artery bears to the posterior wall of the canal. That vessel can be felt (and, indeed, in most cases seen) extending obliquely upwards and medially, posterior to the transversalis fascia, to the lateral border of the rectus. A triangular area is thus mapped out by the artery, the inguinal ligament, and the lateral border of the rectus. It receives the name of the *triangle of Hesselbach*. The triangle lies behind the posterior wall of the inguinal canal, and chiefly behind that part of it which is formed by the falx inguinalis (O.T. conjoined tendon).

In the female the inguinal canal is much smaller than in the male. It has the same boundaries; and it is traversed by the round ligament of the uterus.

Arteries of the Abdominal Wall.—The following arteries will be found in the abdominal wall:—

1. Intercostal and lumbar arteries.
2. The inferior epigastric artery.
3. The deep circumflex iliac artery.
4. The superior epigastric artery.
5. The musculo-phrenic artery.

The *intercostal arteries* of the lower two spaces are prolonged forwards between the internal oblique and the transversus abdominis. They have already been noted accompanying the corresponding nerves. In front, they anastomose with branches of the epigastric arteries, whilst, inferiorly, they effect communications with the lumbar arteries.

The *main stems* of the *lumbar arteries* ramify between the same two muscles as the preceding vessels, but at a lower level in the abdominal wall. Anteriorly, they anastomose with branches of the inferior epigastric artery; above, with the intercostal arteries; and below, with the deep circumflex iliac and the ilio-lumbar arteries.

Arteria Epigastrica Inferior (O.T. Deep Epigastric Artery).—The inferior epigastric branch of the external iliac artery is a vessel of some size. It takes origin about a quarter of an inch above the inguinal ligament. At present it is seen shining through the fascia transversalis and forming the lateral boundary of Hesselbach's triangle. Divide the fascia transversalis along its course and note the two veins which accompany the artery; then study the course and relations of the vessel. At first it runs medially for a short distance, between the inguinal ligament and the abdominal inguinal ring, and then, changing its direction, it is carried upwards and medially on the medial side of the ring towards the lateral border of the rectus abdominis. Continuing upward behind the rectus abdominis it pierces the transversalis fascia, then, passing in front of the linea semicircularis, it enters the sheath of the rectus, in which it ascends vertically, and it terminates, at the level of the lower margin of thorax, in branches which enter the substance of the rectus, where they anastomose with the ramifications of the superior epigastric artery.

In the lower parts of its course the artery is embedded in

the extra-peritoneal fat between the peritoneum and the fascia transversalis; then, having pierced that fascia, it is situated between the fascia and the posterior surface of the rectus; finally, having passed in front of the linea semicircularis, it lies between the rectus and the posterior wall of the sheath of that muscle. In addition to the relations mentioned it has others of equal importance, viz., (1) as it runs upwards it lies close to the medial side of the abdominal inguinal ring; (2) as the spermatic cord traverses the commencement of the inguinal canal it lies in front of the artery, separated from it only by transversalis fascia; (3) as the ductus deferens, or the round ligament of the uterus, passes from the inguinal canal into the abdominal cavity it hooks round the lateral side of the artery.

The *branches* which spring from the inferior epigastric are—

1. External spermatic.
2. Pubic.
3. Muscular.
4. Cutaneous.
5. Anastomotic.

The *external spermatic* is a small twig which supplies the cremaster muscle and anastomoses with the internal spermatic artery. The *pubic*, also insignificant in size, runs medially on the pubis, and sends downwards an obturator branch which anastomoses with a small branch from the obturator artery. The importance of the pubic branch arises from the fact that the anastomosis which it establishes sometimes becomes so large as to take the place of the obturator artery. The *muscular branches* are given to the substance of the rectus, and the *cutaneous offsets* pierce the abdominal muscles and anastomose with the superficial epigastric artery. The *anastomotic branches* pierce the posterior lamella of the internal oblique aponeurosis and anastomose, between the transversus abdominis and the internal oblique muscles, with the lower intercostal, the subcostal, and the lumbar arteries.

Arteria Circumflexa Ilium Profunda.—The deep circumflex iliac artery springs from the lateral side of the external iliac artery, about the same level as the inferior epigastric, and runs laterally, behind the inguinal ligament, to the anterior superior spine of the ilium. From that point onwards it takes the crest of the ilium as its guide, and it ends by anastomosing with branches of the ilio-lumbar artery. At first it is placed in the extra-peritoneal fat, between the fascia transversalis and the peritoneum. Its course behind the inguinal ligament is

indicated by a whitish line, which marks the union of the fascia transversalis and fascia iliaca. If the transversalis fascia is divided along that line the deep circumflex iliac artery will be exposed. At the anterior superior spine of the ilium the vessel pierces the fascia transversalis, and lies between that and the transversus muscle; and lastly, about the middle point of the iliac crest, it pierces the transversus muscle, and its terminal twigs ramify between the transversus abdominis and the internal oblique muscles. Thus the artery gradually approaches the surface, as it passes from its origin to its termination.

The dissector has already seen the *ascending branch* which it sends upwards between the internal oblique and transverse muscles.

Art. Epigastrica Superior et Art. Musculo-phrenica.—The superior epigastric and the musculo-phrenic arteries are the two terminal branches of the internal mammary artery.

The *superior epigastric* will be found behind the rectus muscle and within the upper part of its sheath. It gives twigs to the rectus, and anastomoses with the inferior epigastric and the intercostal arteries.

Dissection.—To expose the musculo-phrenic artery detach the transversus abdominis from its attachments to the rib cartilages. The artery will be found, if the injection of the arteries has been good, at the level of the eighth or ninth costal cartilage, where it passes through the diaphragm. Follow it along the costal margin, across the abdominal surface of the costal origins of the diaphragm.

The Musculo-phrenic.—In the abdomen the musculo-phrenic artery passes downwards and laterally, along the costal origin of the diaphragm, from the point where it pierces the diaphragm to the last intercostal space. Before or after it enters the abdomen it supplies anterior intercostal branches to the seventh, eighth, and ninth intercostal spaces (see p. 121). After it enters the abdomen it gives branches to the diaphragm, and other branches which anastomose with twigs from the superior epigastric and the lower two aortic intercostal arteries.

Dissection.—The transversus has already been detached from the inguinal ligament and the crest of the ilium (p. 225), and also from the rib cartilages. Now divide it vertically between the ribs and the iliac crest, and throw it towards the median plane, carefully detaching the transversalis fascia from its deep surface. The muscle fibres end anteriorly in an aponeurosis; the lower part of the aponeurosis, which blends with the lower

part of the aponeurosis of the internal oblique to form the falx inguinalis, has already been examined (see p. 214). The upper part enters into the formation of the sheath of the rectus abdominis; from the lower margin of the thorax to halfway between the umbilicus and the symphysis pubis it blends with the posterior lamella of the internal oblique aponeurosis, medial to the border of the rectus, and it takes part, therefore, in the formation of the posterior part of the sheath of the rectus. Below halfway between the umbilicus and the symphysis pubis it passes in front of the rectus and blends with the aponeurosis of the external and internal oblique muscles to form the lower part of the anterior wall of the sheath.

In the area lateral to the sheath of the rectus abdominis the only structures which now separate the dissector from the cavity of the abdomen are, the transversalis fascia, the extra-peritoneal fat, and the peritoneum. Do not attempt to reflect the transversalis fascia as a whole, but make an incision through it, near the margin of the ribs or near the iliac crest, to display the extra-peritoneal fat, then scrape away the fat to display the peritoneum; finally, make a small incision through the peritoneum and insert the finger through it into the abdomen, but do not enlarge the opening, and do not disturb the contents of the abdomen.

If the subject is a male the dissectors should now examine the scrotum, and after they have gained a general idea of its constituent parts they should proceed to dissect it.

Scrotum.—The scrotum is a pendulous purse-like arrangement of the skin and superficial fascia for the lodgment of the testes. The skin composing it is of a dark colour and rugose, and is traversed, along the middle line, by a *median raphe* or ridge, which indicates its bilateral character.

The superficial fascia possesses certain characters peculiar to itself. It has a ruddy colour, and is totally devoid of fat. The ruddy tint is due to the presence of involuntary muscular fibres which take the place of the fat, and constitute what is called the *dartos muscle.* The rugosity of the scrotal skin is maintained by the tonic contraction of the fibres of the dartos muscle. But, further, the dartos muscle forms an imperfect septum or partition, which divides the interior of the scrotum into two chambers—one for each testis. The points mentioned in connection with the construction of the scrotum have all, to a certain degree, been noted in the dissection of the perineum.

The two scrotal tunics, however, are not the only coverings of the testis. Each constituent of the abdominal wall has been seen to contribute an investment to the spermatic cord, and each in turn is continued down so as to clothe the testis. Presuming, then, that the skin and superficial fascia

are reflected, the testis and cord within the scrotum will still be found to be invested by:—

1. The external spermatic fascia, from the aponeurosis of the external oblique.
2. The cremasteric fascia—the muscular element of which is derived partly from the internal oblique.
3. The internal spermatic fascia, from the fascia transversalis.

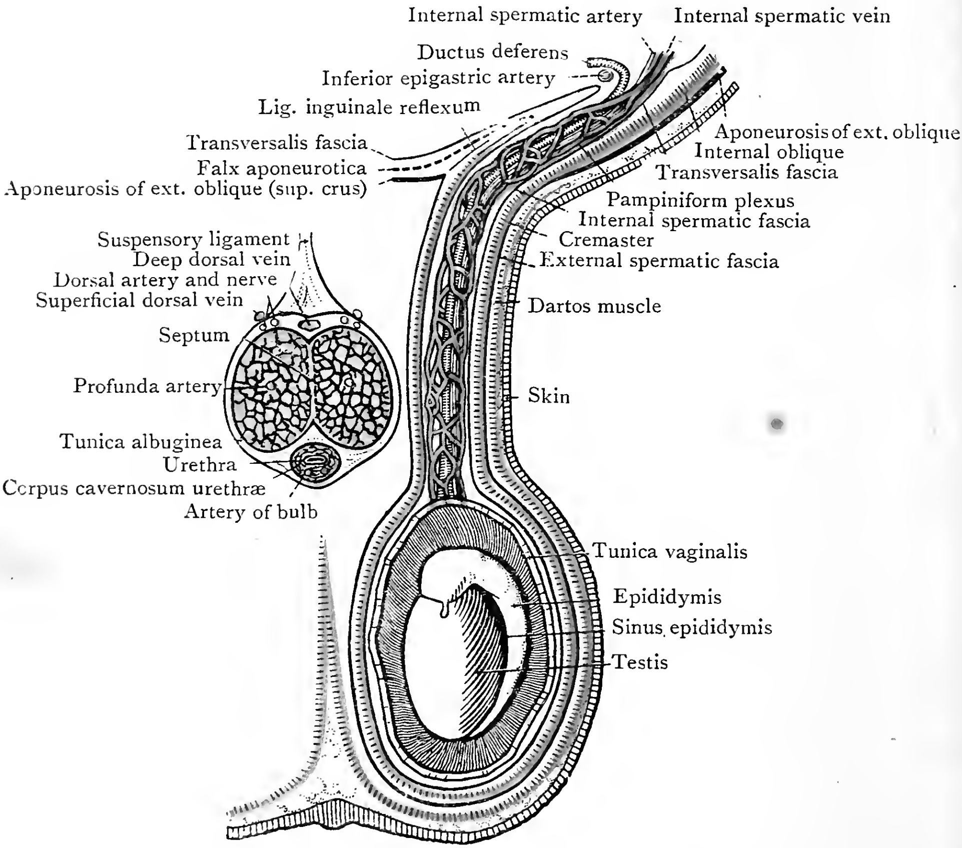

FIG. 102.—Diagram of a Frontal Section through the Penis and the Left Part of the Scrotum.

Within the skin and the dartos muscle, and the three coverings derived from the three layers of the wall of the abdomen, there is an additional covering of the testis called the *tunica vaginalis* (Figs. 102, 105).

The tunica vaginalis is an invaginated serous sac, derived from the lower end of a tube-like process of the peritoneum which descended into the scrotum in the early stages of

development, and at that time its cavity was continuous with the cavity of the peritoneum. In the later stages of intra-uterine life the upper part of the process is obliterated, and the lower part remains as the tunica vaginalis, which surrounds the testicle everywhere except along its posterior border.

From the above description the student will understand that there is only *one* tunic common to both testes, viz., the integument; that the superficial fascia and dartos, forming the dartos tunic, and the investments derived from the abdominal wall, constitute special tunics for each testis.

Dissection.—In cases of old inguinal herniæ where the various layers covering the spermatic cord have become thickened, they can be separated and displayed to advantage, but in an ordinary case the student will find that whilst the skin, the dartos, and the tunica vaginalis are readily identified, the external spermatic fascia, the cremasteric fascia, and the internal spermatic fascia are less easily defined, and a satisfactory demonstration of them is difficult. Nevertheless the attempt should be made, and if the steps to be described are followed an excellent demonstration of the constituent parts of the spermatic cord will be obtained.

On the left side make an incision through the skin of the antero-lateral aspect of the scrotum, from the region of the subcutaneous inguinal ring to the lower end of the scrotum; then reflect the medial part of the divided skin towards the median plane. Remember that the superficial fibres of the dartos are attached to the skin, and therefore keep the edge of the scalpel playing strictly against the skin as the reflection proceeds. Carry the reflection beyond the median plane to demonstrate the fact that the skin forms a common sheath for both testicles, and does not send a deep lamella between them. When the skin is reflected the yellowish-pink layer of dartos tissue is obvious. Make an incision through it similar to the incision through the skin and reflect the medial part towards the median plane. As the median plane is reached a layer of the deep part of the dartos will be found extending upwards as a septum between the testicles. The dartos therefore forms a covering for each testicle, but the covering is incomplete, for the septum of the dartos is incomplete above. The layer of somewhat loose areolar tissue exposed by the reflection of the dartos is the external spermatic fascia. With the handle of the scalpel and the fingers separate it from the deep surface of the dartos. Begin the separation at the lower end of the scrotum and proceed upwards to the subcutaneous inguinal ring. When the separation is completed, the testicle and the spermatic cord with their remaining coverings are free. Examine now the extra-peritoneal fatty tissue which lies behind the abdominal inguinal ring. Note that a process of this tissue is prolonged downwards with the cord. Now, with the handle of the knife, gently separate the extra-peritoneal fat from the subjacent peritoneum. Behind the abdominal inguinal ring the peritoneum shows a slight bulging forwards, and a slender fibrous band may be detected passing into the cord from the most

prominent part of this bulging. The fibrous cord is the remains of the tube of peritoneum which, in the fœtus, connected the serous investment of the testis (the tunica vaginalis) with the general peritoneal lining of the abdomen. In some cases it may be traced as far as the testis, but more commonly it extends down the cord only for a short distance ; indeed, it is frequently absent.

To obtain a proper conception of the fibrous thread, it is necessary that the student should understand that neither the testis nor the tunica vaginalis are developed in the scrotum. In the early months of fœtal life the rudimentary scrotum contains neither tunica vaginalis nor testis ; the testis lies on the posterior wall of the abdomen, projecting forwards into the great serous cavity of the abdomen, which is called the peritoneal cavity. The wall of the peritoneal cavity is formed by a membrane called the peritoneum, and the inner surface of the membrane is lined with a layer of flat epithelium —peritoneal epithelium. The peritoneum which is in contact, externally, with the wall of the abdomen is called the *parietal peritoneum* ; but here and there the posterior wall of the peritoneal sac is invaginated by one or other of the abdominal viscera. When the invaginating viscus carries forward more peritoneum than is necessary to cover its surfaces, the excess of peritoneum forms a fold which connects the viscus with the posterior wall of the abdomen ; such folds are called *mesenteries* and they connect the peritoneum covering the invaginating viscus, which is termed the *visceral peritoneum*, with the parietal peritoneum lining the inner surface of the abdominal wall. The testis is developed in the lumbar region ; and it projects forwards into the peritoneal cavity, covered with a layer of epithelium which is continuous with the peritoneal epithelium. It also invaginates a portion of the wall of the peritoneal sac and so produces a mesentery connecting the testis and the epithelium which covers its surface with the parietal peritoneum ; this mesentery is called the *mesorchium*.

The testis and its mesorchium gradually descend in the wall of the peritoneal sac to the inguinal region ; and, at the same time, a diverticulum of peritoneum, the *processus vaginalis*, is projected through the inguinal portion of the abdominal wall into the scrotum, producing by its passage the inguinal canal, and prolonging the cavity of the peritoneum into the scrotum. During the latter part of the seventh and the

early part of the eighth month of fœtal life the testis, with its epithelium and its mesorchium, descends along the posterior wall of this diverticulum, and during the ninth month it comes to rest near the lower end of the scrotum, where it projects forwards in the posterior wall of the lower part of the processus vaginalis. In the meantime, the cavity of the upper part of the processus vaginalis disappears and its peritoneal

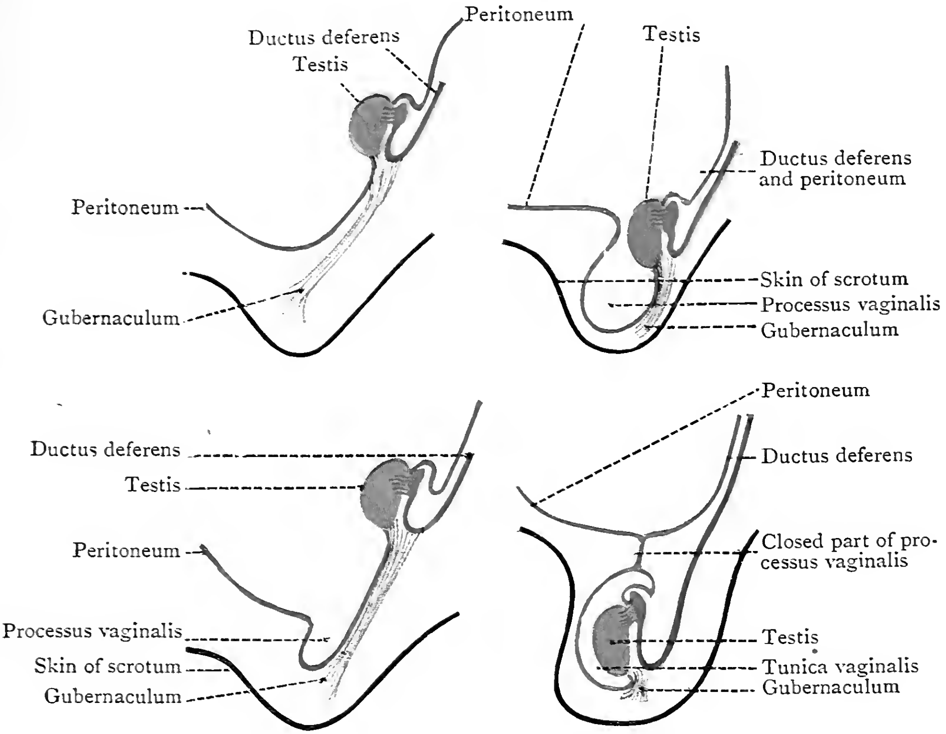

FIG. 103.—Diagrams illustrating the Descent of the Testis and the Derivation of the Tunica Vaginalis from the peritoneal lining of the abdominal cavity.

wall forms a solid fibrous cord (*Rudimentum processus vaginalis*). The lower part of the sac, thus cut off, is the tunica vaginalis of the testis. Its cavity is now entirely separated from the cavity of the peritoneum, but its wall is still connected with the peritoneum, for a longer or shorter time, by the fibrous cord which is the remains of the upper part of the processus vaginalis. In most cases, however, that cord undergoes atrophy, from below upwards, and in many cases, as already mentioned, it entirely disappears.

The orifice of communication between the processus vaginalis and the peritoneal cavity is closed usually before birth; and the cavity of the upper portion of the process, from the abdominal inguinal ring to the persistent tunica vaginalis, is generally obliterated during the first month of extra-uterine life.

The cause of the descent of the processus vaginalis and the testis is still a subject of dispute. It has been suggested:—(1) that it is due to different growth energy in adjacent parts; (2) to traction from below, produced by a musculo-fibrous cord, the *gubernaculum of the testis*, which grows through the inguinal part of the abdominal wall and is attached to the interior of the scrotum, whilst, above, it is attached to the testis and the adjacent peritoneum; (3) to the action of intra-abdominal pressure, tending to displace the testis downwards.

Funiculus Spermaticus.—The spermatic cord is formed by the association together of certain blood-vessels, nerves, and lymph vessels, along with the ductus deferens, all of which are proceeding to or passing from the testis. The structures come together at the abdominal inguinal ring, and that may be taken as the point at which the cord begins. The cord has already been traced in its course through the inguinal canal, and has been observed to issue from the canal through the subcutaneous inguinal ring. It is now seen as it lies within the scrotum suspending the testis.

Constituent Parts of the Spermatic Cord.—The following are the structures which form the spermatic cord:—

1. The ductus deferens (O.T. vas deferens).
2. Blood-vessels.
   - Arteries.
     - The internal spermatic.
     - The external spermatic.
     - The artery to the ductus deferens.
   - Veins.
     - The pampiniform plexus of veins.
3. Lymph vessels.
4. Nerves.
   - External spermatic.
   - Sympathetic twigs.
5. A fibrous strand.

The constituent parts are all held together by loose areolar tissue which intervenes between them, and also by the investments which are given to the cord by the abdominal wall.

Dissection.—The dissection of the sheaths and the constituent parts of the extra-abdominal part of the spermatic cord is best done under water. Divide the cord at the abdominal inguinal ring; place the cord and the testicle with their coverings in a cork-lined tray; fasten the testicle and the cord to the cork

with pins, and fill the tray with water. Divide the external spermatic fascia longitudinally and turn it aside; next make a longitudinal incision through the cremasteric fascia along the cord and reflect the divided fascia downwards over the testicle. The cremasteric fascia consists of strands of muscle intermingled with fibrous tissue. Then deal in a similar manner with the internal spermatic fascia, and, as the testicle is approached, be careful not to injure the tunica vaginalis. After the internal spermatic fascia has been reflected, dissect out the constituent parts of the spermatic cord from the areolar tissue in which they are embedded, and by which they are still surrounded. In the anterior part of the cord lie the anterior veins of the pampiniform plexus and the internal spermatic artery. In the posterior part are the posterior veins of the pampiniform plexus and between the two groups of veins is the ductus deferens accompanied by its artery.

Ductus Deferens (O.T. **Vas Deferens**).—The ductus deferens is the duct through which the spermatozoa pass from the testicle to the urethra. It is, therefore, the most important constituent of the cord. It can always be distinguished, both in the living and the dead body, by the hard, firm, cord-like sensation which it gives when the spermatic cord is held between the index finger and the thumb. It commences at the lower end of the testicle, and ascends, behind the testicle, to the spermatic cord. In the cord it lies posteriorly, behind the internal spermatic artery and the larger anterior group of veins of the pampiniform plexus. At the subcutaneous inguinal ring it enters the inguinal canal and passes through the canal, still accompanied by the veins and arteries. At the abdominal inguinal ring it leaves the internal spermatic artery, and the internal spermatic vein in which the pampiniform plexus has ended, and, accompanied by the artery to the ductus deferens, it hooks round the inferior epigastric artery and passes into the pelvis. Its pelvic course is described on p. 451.

The *artery to the ductus deferens* is a small branch from a superior vesical. It passes along the duct to the testis.

The *external spermatic artery* is a branch of the inferior epigastric; it has already been seen entering the cremaster muscle. The *external spermatic nerve*, a branch of the genito-femoral nerve, has a similar destination. It has been displayed in a previous stage of the dissection.

The *internal spermatic artery* arises, within the abdomen, from the front of the aorta; it enters the cord at the abdominal inguinal ring, and proceeds to the testis, into the

posterior border of which it sinks, after dividing into several smaller twigs. The *testicular veins* issue from the testis at its posterior border, and, as they pass upwards, they form, in the cord, a bulky plexus, which is termed the *pampiniform plexus*. A single vessel, the *spermatic vein*, issues from the plexus, and enters the abdomen through the abdominal inguinal ring. On the right side it pours its blood into the inferior vena cava; on the left side it joins the left renal vein.

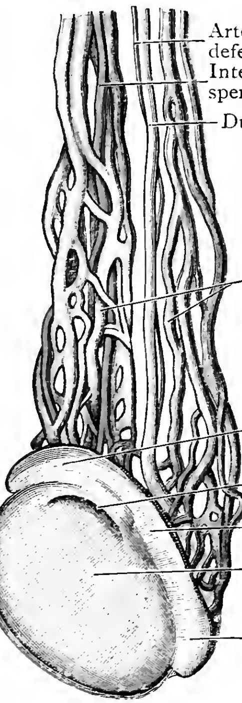

FIG. 104.—Dissection of the Left Spermatic Cord to show its constituent parts. (From Waldeyer, modified.)

The *sympathetic filaments* extend downwards upon the internal spermatic artery. They come from the renal and aortic plexuses.

The *spermatic lymph vessels* enter the abdomen through the abdominal inguinal ring, and join the lumbar glands.

Dissection. — The tunica vaginalis has still to be examined. It is an invaginated sac which surrounds both the testicle and the epididymis, which lies at the lateral side of the posterior part of the testicle.

To demonstrate the extent of the sac make a small incision through the anterior part of its wall; then introduce a blowpipe through the incision and distend the cavity. When the distension is completed it will be seen that the sac is much more extensive than the structures it surrounds. It envelops them everywhere except posteriorly, passes upwards beyond them, on the front of the lower part of the spermatic cord, and also downwards below them for a short distance. Now, with the aid of scissors open the sac by enlarging the incision through which the blowpipe was passed, both upwards and downwards, to the upper and lower limits of the cavity. When the cavity has been laid open the difference between the inner and outer surfaces of the tunica vaginalis will be obvious. The outer surface which was connected with the inner surface of the internal spermatic fascia, by loose areolar tissue, is rela-

tively rough and flocculent, but the inner surface is smooth and glistening.

Tunica Vaginalis.—The tunica vaginalis is an invaginated serous sac. The uninvaginated portion which lies in relation with the inner surface of the internal spermatic fascia is called the *parietal* or *scrotal* portion. The inner or invaginated part is the *visceral* or *testicular* portion; it covers the

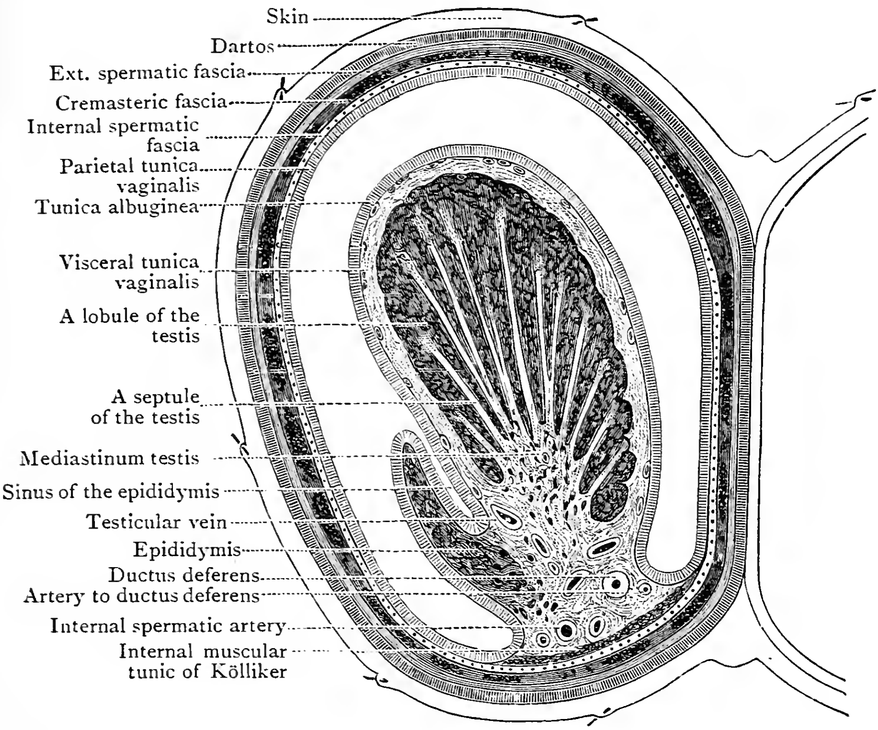

FIG. 105.—Transverse section through the left side of the Scrotum and the Left Testis, seen from above. The sac of the tunica vaginalis is represented in a distended condition.

surfaces and anterior borders of the testicle and epididymis, and at their posterior borders it is continuous with the parietal portion. In ordinary circumstances the parietal and visceral layers are separated from one another only by a thin layer of fluid, which diminishes friction when the layers move over one another, and the cavity of the sac is merely a potential cavity; but in some abnormal circumstances the fluid increases in quantity, the walls of the sac

are forced apart, and the condition called hydrocele is produced.

On the lateral side of the testicle a portion of the cavity projects backwards between the testicle and the medial face of the epididymis; it is called *the sinus of the epididymis* (Figs. 102, 105).

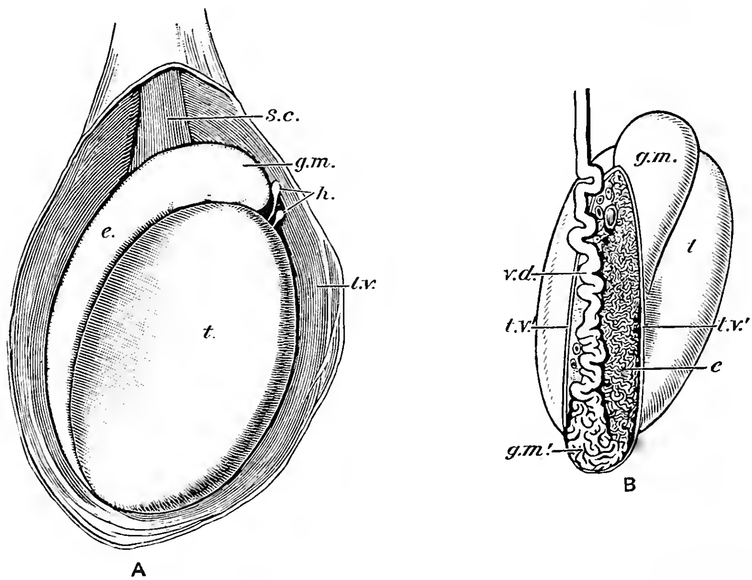

FIG. 106.

A. The Right Testis and Epididymis within the tunica vaginalis. (A. F. Dixon.)

s.c. Spermatic cord.
g.m. Caput epididymidis.
e. Corpus epididymidis.
t. Testis.
h. Appendices testis (Morgagni).
t.v. Tunica vaginalis.

B. The Right Testis and Epididymis seen from behind, after removal of the parietal part of the tunica vaginalis. (A. F. Dixon.)

t.v'. Cut edge of tunica vaginalis along the line where the *parietal part* becomes continuous with the *visceral part.*
v.d. Ductus deferens.
g.m'. Cauda epididymidis.

Testis.—Each testicle invaginates the posterior wall of the corresponding tunica vaginalis. It is an oval body with flattened sides and it varies considerably in size, but averages about 38 mm. (one and a half inches) in length, 25 mm. (one inch) in antero-posterior diameter, and somewhat less than that from side to side.

It is free, except above and behind where it is connected

with the epididymis and is covered everywhere, except along its posterior border, by the visceral layer of the tunica vaginalis. Its efferent ducts issue from its upper end and enter the epididymis, whilst its vessels and nerves pass through its posterior border. It lies somewhat obliquely in the scrotum, its superior extremity being directed forwards and upwards, and the left testis, as a rule, hangs at a lower level than the right. Attached to the upper part of the anterior border of the testis, in front of the head of the epididymis one or two small pear-shaped bodies may be found. They are the *appendices testis*, and are remnants of embryonic structures. One appendix is, usually, stalked, the other is smaller and sessile.

Epididymis.—The epididymis is a comma-shaped structure which lies along the lateral side of the posterior border of the testis from its upper to its lower end. The enlarged upper end of the epididymis is the *caput epididymidis*; the thin lower end is the *cauda epididymidis*, and the intervening part is the *corpus epididymidis.*

The caput epididymidis surmounts the superior extremity of the testis like a helmet, and is attached to it both by the visceral tunica vaginalis, which is continued over it, and also by the *ductuli efferentes*, which pass from the testis into the epididymis. The *cauda epididymidis* is fixed to the back of the testis merely by the visceral tunica vaginalis and some intervening areolar tissue. The *body of the epididymis* is separated from the body of the testis by an involution of the serous covering which forms the wall of the *sinus epididymidis.*

The *ductus deferens* emerges from the inferior extremity of the tail of the epididymis and then passes upwards, upon the posterior margin of the testis and on the medial side of the body and head of the epididymis. By this relation, the side to which a given testis belongs can be readily detected.

The vessels of the testis and the epididymis enter and emerge from their posterior margins.

Dissection.—Some of the main facts relating to the structure of the testis may be learned by a careful naked-eye examination of its different parts. For that purpose place it in a cork-lined tray and dissect it under water. Having fixed it to the bottom of the tray, with pins, begin by tracing the blood-vessels into the gland. As that is done, a quantity of involuntary muscular tissue spread over the posterior border of the testis and the epididymis becomes apparent. It is the *inner muscular tunic*

of Kölliker. Now free the tail and body of the epididymis from the back of the gland by cutting the serous covering as it passes from one to the other, and breaking through the fibrous tissue which intervenes between the tail and the lower part of the testis. Do not interfere with the head of the epididymis. When the body and tail of the epididymis are turned aside, the testis should be divided transversely, with a sharp knife, about its middle, into an upper and a lower portion.

Structure of the Testis.—The cut surface of the lower part of the testis should now be studied. The dense, tough fibrous coat which envelops it, under cover of the visceral layer of the tunica vaginalis, is the *tunica albuginea.*

At the posterior border of the testis the tunica albuginea forms a thickened ridge, called the *mediastinum testis*, which projects forwards into the interior of the testis.

The mediastinum testis extends along the whole length of the posterior border of the gland. It is traversed by the arteries, veins, and lymph vessels of the testis, and, in addition, it is tunnelled by a plexus of intercommunicating seminal channels which form, collectively, the *rete testis.*

From the front and sides of the mediastinum testis radiating fibrous strands pass through the substance of the testis. They are the cut margins of incomplete fibrous septula which extend towards the deep surface of other parts of the tunica albuginea and become connected with them (Figs. 105, 107). By means of the partitions, the space enclosed by the tunica albuginea becomes broken up into a large number of partially separated lobules or compartments, two to three hundred in number. The fibrous framework of the testis consists therefore of the tunica albuginea with the mediastinum testis and the septula.

The blood-vessels have a very definite arrangement with reference to fibrous framework. After they have passed through the mediastinum they spread out upon the surfaces of the fibrous septula and on the deep surface of the tunica albuginea. The vascular mesh-work thus formed is sometimes called the *tunica vasculosa.*

The proper glandular substance of the testis is lodged within the compartments described above. It consists of four to six hundred fine hair-like tubes, termed the *contorted seminiferous tubules*, each of which is about 60 cm. (two feet) long. Two or more occupy each compartment, and constitute what is called a *testicular lobule.* In each testicular lobule the

tubes are coiled and convoluted to an extraordinary degree, and the coils are surrounded and bound together by connective tissue, which contains a large number of peculiar cells known as the *interstitial cells* of the testicle.

Approaching the mediastinum testis, the tubuli seminiferi contorti join each other at acute angles and form a smaller number of tubes, which finally become straight and considerably reduced in diameter. These are called the *tubuli seminiferi recti.* They enter the mediastinum and join the *rete testis.*

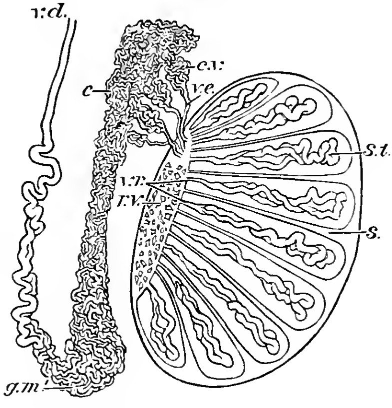

FIG. 107.—Diagram illustrating the Structure of the Testis. (A. F. Dixon.)

v.d. Ductus deferens.
g.m'. Cauda epididymidis.
c. Caput epididymidis.
c.v. Lobuli epididymidis.
v.e. Ductuli efferentes testis.
v.r. Tubuli seminiferi recti.
r.v. Rete testis.
s.t. Contorted seminiferous tubule.
s. Septula testis.

Dissection.—Attempt to unravel some of the tubuli of the testis, under water, with the aid of forceps and a probe. It will not be possible, under ordinary circumstances, to open them out fully, but a sufficiently good demonstration of their general arrangement may be made. Afterwards the tubuli should be removed from the lower part of the testis, by the use of the forceps, aided by a stream of water. A good view of the fibrous framework of the testis will then be obtained.

The dissector must next endeavour to ascertain the manner in which the secretion of the testis passes from the rete testis into the epididymis. For that purpose the upper part of the testis, with the attached epididymis, must be examined. Gently raise the caput epididymidis from the surface of the testis, by dividing the visceral part of the tunica vaginalis which binds them together, and carefully break down the intervening connective tissue. Under favourable circumstances the *ductuli efferentes,* which pass from the rete testis to the tube of the epididymis, may be seen.

Structure of the Epididymis.—The *ductuli efferentes testis* are fifteen to twenty delicate ducts. They leave the upper part of the rete testis, and pass into the caput epididymidis. In the caput the ductuli efferentes become coiled and form a series of small conical masses, called the *lobuli epididymidis.* Ultimately the efferent ducts open into a single convoluted

canal, termed the *ductus epididymidis.* The head of the epididymis is thus composed of the lobules of the epididymis and part of the coiled duct of the epididymis embedded in areolar tissue. The body and tail of the epididymis are formed of the continuation of the same canal, coiled and convoluted upon itself to a remarkable degree.

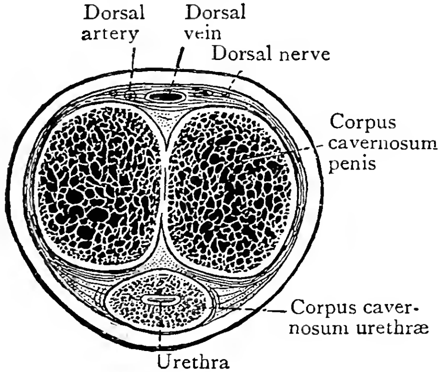

FIG. 108.—Transverse section through the body of the Penis.

The intricacy of its flexuosities will be better understood by simply stating that if the tube were completely opened out it would be found to measure 6 meters (twenty feet) or more. At the lower end of the tail of the epididymis the duct of the epididymis becomes continuous with the ductus deferens.

Dissection.—**The dissector should endeavour to unravel a part of the ductus epididymidis. The coils are held together by areolar tissue and the dissection is very tedious.**

Penis.—The penis was studied, to a certain extent, when the perineum was dissected and its two main constituent parts—the *corpus cavernosum penis* and the *corpus cavernosum urethræ*—were partially examined. It was noted also, at that time, that the corpus cavernosum penis divides, posteriorly, into the two crura of the penis, each of which is attached to the corresponding side of the pubic arch. Anteriorly the corpus cavernosum penis ends in a blunt rounded extremity which is covered by the glans penis (Figs. 82, 109).

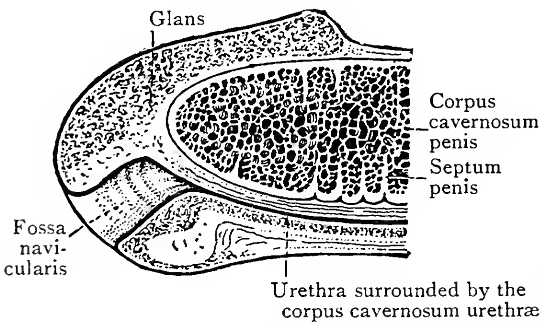

FIG. 109.—Median section through the terminal part of the Penis.

The anterior and posterior parts of the corpus cavernosum urethræ are both expanded. The posterior expanded part forms the *bulb of the urethra*, which is attached to the median part of the inferior fascia of the urogenital diaphragm. The anterior expanded portion forms the *glans penis*, which forms a cap over the blunt anterior end of the corpus cavernosum penis (Fig. 109).

The glans penis is conical in shape and the projecting margin of its base is called the *corona glandis*.

The urethra traverses the whole length of the corpus cavernosum urethræ, entering the bulb, from above, at the inferior fascia of the urogenital diaphragm, and terminating at the extremity of the glans as a vertical fissure, called the *orificium urethræ externum* (O.T. *meatus urinarius*).

The *integument of the penis* is remarkable for its great delicacy and elasticity, and the absence of hairs. It has a brownish tint, and is freely movable over the organ. At the glans the skin leaves the body of the penis, and, passing for a variable distance over the glans, is folded back upon itself so as to form the *prepuce* (Figs. 85, 113). The deep layer of the prepuce reaches the penis again behind the corona glandis, and is then reflected forwards over the glans to become continuous with the mucous membrane of the urethra at the external urethral orifice. A slight fold will be observed on the under surface of the glans, extending from the lower angle of the external orifice to the prepuce; this is the *frenulum preputii.*

Dissection.—Make a longitudinal incision along the dorsum of the penis, from the front of the symphysis pubis to the extremity of the prepuce, and reflect the skin to each side. The superficial fascia, which is thus exposed, consists of loose areolar tissue devoid of fat. Next clean the suspensory ligament of the penis (see p. 200), which descends from the front of the symphysis, and note that, as it reaches the dorsum of the body of the penis, it splits into right and left layers which fuse with the deep fascia at the sides of the penis. After the suspensory ligament is displayed find the superficial dorsal vein which runs backwards, in the superficial fascia, in the median plane. It ends posteriorly in the superficial external pudendal vein of one or both sides. Now clean away the superficial fascia, and expose the deep fascia. It forms a fibrous envelope for the body of the penis, enclosing both the corpus cavernosum penis and the corpus cavernosum urethræ.

After the deep fascia has been examined divide it, along the median line, on the dorsum of the penis. Immediately beneath it, in the median plane, find the deep dorsal vein. Clean the

deep vein and note that, at the symphysis, it passes backwards, between the two laminæ of the suspensory ligament, to join the pudendal plexus. Between the laminæ of the suspensory ligament on each side of the deep dorsal vein find the dorsal arteries and nerves of the penis and trace them forwards towards the glans.

Suspensory Ligament of the Penis.—The suspensory ligament of the penis is a strong fibro-elastic band of a triangular shape. By its posterior border it is attached to the symphysis pubis. Towards the penis it separates into a right and a left lamella, which join the deep fascia of the body of the organ. Between the two lamellæ are placed the dorsal vessels and nerves (Figs. 92, 106).

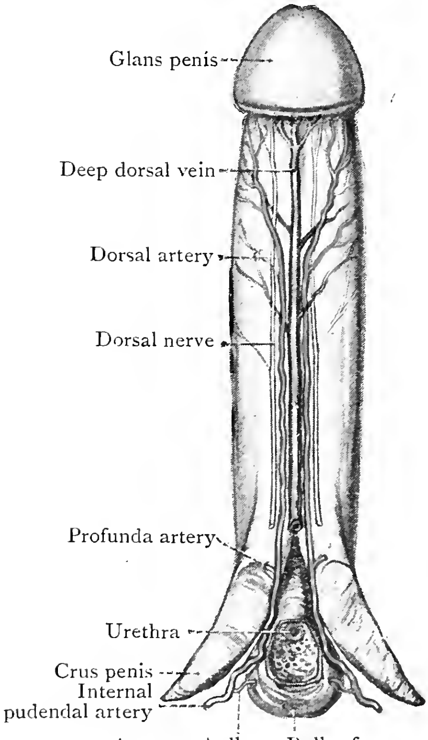

FIG. 110.—Upper Aspect of the Penis, showing the main Blood-Vessels and Nerves.

Dorsal Vessels and Nerves.—In the median line of the dorsum of the penis, in the superficial fascia, lies the *superficial dorsal vein*, and, under cover of the deep fascia, in the groove which extends along the middle line of the dorsum of the corpus cavernosum penis, the larger *deep dorsal vein* is situated. A short distance lateral to the deep dorsal vein are the *right and left dorsal arteries* and lateral to the arteries are the *dorsal nerves*. On the dorsum of the penis, therefore, there are two veins, superficial and deep; two arteries; and two nerves.

The *superficial dorsal vein* receives tributaries from the prepuce and terminates posteriorly in the superficial external pudendal veins.

The *deep dorsal vein* of the penis begins by the union of several twigs from the glans and prepuce. It extends backwards in the middle line, passes between the two layers of

the suspensory ligament, and enters the pelvis after passing below the arcuate ligament of the pubis. It ends by joining the pudendal plexus of veins.

The *dorsal arteries* are terminal twigs of the internal pudendal arteries. They pass forward between the two layers of the suspensory ligament, and, continuing their course, on the dorsum of the penis, they terminate in branches to the glans penis.

The *dorsal nerves* are branches of the pudendal nerve. They accompany the arteries, and end in fine twigs to the papillæ of the glans.

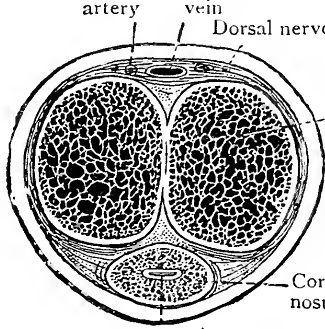

FIG. 111.—Transverse section through the body of the Penis.

Dissection.—Make a transverse section through the corpora cavernosa of the penis and urethra, but leave the skin on the inferior surface undivided in order that the two segments of the divided organ may remain connected until the urethra has been examined at a later stage. After the section has been made examine the naked-eye structure of the divided parts.

Structure of the Corpus Cavernosum Penis.—The corpus cavernosum penis consists of a spongy tissue, called cavernous tissue, surrounded by a dense white fibrous sheath called the tunica albuginea of the corpus cavernosum, and it is divided into right and left halves by a median fibrous septum, *the septum penis.* The septum is incomplete; numerous vertical clefts, which are not recognisable in the transverse section, pass through it; the clefts may, however, be seen if the cavernous tissue is dissected away from the septum for a short distance on one or the other side. The fibrous stroma of the cavernous tissue is connected with the deep surface of the tunica albuginea. In the centre of each half of the divided corpus cavernosum penis the divided profunda artery may be seen.

Structure of the Corpus Cavernosum Urethræ.—The corpus cavernosum urethræ also consists of cavernous tissue, but the meshes of the cavernous reticulum are finer than those of the corpus cavernosum penis. The fibrous sheath

which surrounds the corpus cavernosum urethræ is thinner and less dense than that of the corpus cavernosum penis.

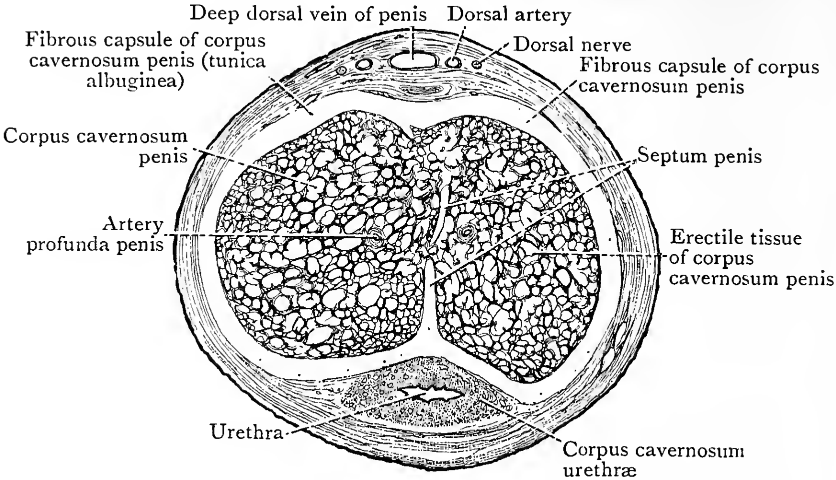

FIG. 112.—Transverse section through the anterior part of the body of the Penis.

In the centre of the corpus cavernosum urethræ the divided urethra will be seen and, in a well-injected specimen, the

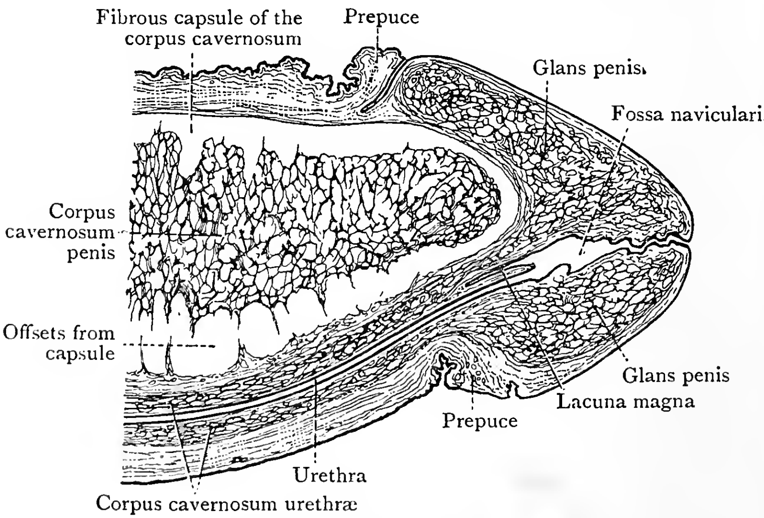

FIG. 113.—Median section through terminal part of the Penis: Prepuce extremely short.

divided arteries of the bulb may be seen, one on each side.

The dissector should note that in a transverse section of

the penis six arteries may be met with. They are the two dorsal arteries, the two profunda arteries, and the two arteries to the bulb of the penis.

Trigonum Lumbale and Lumbar Fascia.

On the sixth day after the body was placed on its back it will be turned upon its face, with blocks supporting the thorax and pelvis, and in that position it will remain for five days. At the end of the first or the beginning of the second day of the period, after the dissector of the upper extremity has cleaned the latissimus dorsi, the dissector of the abdomen must take the opportunity of examining the posterior border of the external oblique. As the posterior border of the muscle passes from the last rib to the external lip of the iliac crest it is quite free, and, in many cases, there is a small triangular interval between it and the lower part of the lateral border of the latissimus dorsi in which the fibres of the more deeply situated internal oblique can be seen. The triangle is the *trigonum lumbale* (*Petiti*). It is a comparatively weak region of the abdominal wall, and in some rare cases hernia of the abdominal contents occurs through it. Not uncommonly, however, the lateral border of the latissimus dorsi overlaps the posterior border of the external oblique, and in those cases the trigonum lumbale does not exist.

On the third day, after the dissector of the upper extremity has reflected the muscles which connect the upper extremity with the trunk on the posterior aspect, the dissector of the abdomen, in association with the dissector of the head and neck, should examine the lumbar fascia and the lumbar origins of the internal oblique and the transversus abdominis muscles.

The lumbar fascia is a portion of the lumbo-dorsal fascia which binds down the deep muscles of the back at the sides of the spines of the vertebrae. In the thoracic region it is a thin transparent lamina which extends from the spines of the vertebræ to the angles of the ribs. At the upper end of the thoracic region it disappears into the neck under cover of the serratus posterior superior. In the lumbar region it becomes much stronger and more complicated. Above, it is continuous with the thoracic portion of the fascia and is

attached to the last rib. Medially, it is attached to the tips of the spines and transverse processes, and to the fronts of the transverse processes of the lumbar vertebræ; laterally, it is connected with the transversus abdominis and the internal oblique, and, below, it is closely attached to the posterior part of the external lip of the iliac crest. In the pelvic region it is attached to the spines of the sacrum, and to the back of the lower part of the sacrum and to the back of the coccyx. In the lumbar region its posterior lamella covers the rounded column of the sacro-spinalis muscle, and to this

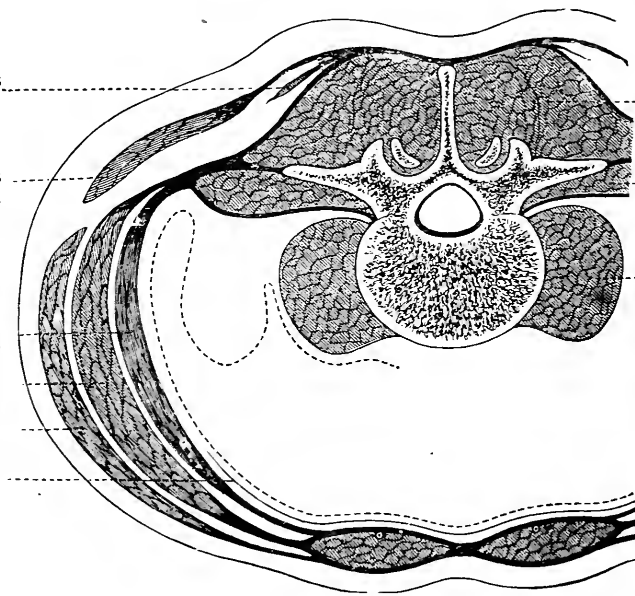

FIG. 114.—Lumbar fascia and sheath of Rectus abdominis. The dotted line represents the Peritoneum.

part the remains of the origin of the latissimus dorsi and the serratus posterior inferior will be found attached.

Dissection.—Clear away the remains of the latissimus dorsi and clean the serratus posterior inferior, which extends upwards and laterally to its attachment to the lower four ribs. It must be cut through at right angles to its fibres and turned aside, its nerves of supply, from the anterior branches of the lower thoracic nerves, being sought for on its deep surface. The remains of its origin from the lumbar fascia must be cleared away and then a vertical incision must be made through the fascia, midway between the medial and lateral borders of the rounded mass of the sacro-spinalis muscle; at each end of the longitudinal incision a transverse incision must be made, one just below the last rib

and the other just above the iliac crest. The transverse incisions should commence at the median plane and should not extend beyond the lateral margin of the mass of sacro-spinalis muscle. The medial part of the divided fascia must be turned to the median plane and its attachments to the tips of the spines verified. The lateral part should be pulled laterally, and at the lateral border of the mass of the sacro-spinalis it will be found to blend with a deeper, middle, layer. Push the sacro-spinalis medially and follow the middle lamella to its attachment to the tips of the transverse processes. The dissectors should then note that the upper fibres of origin of the internal oblique spring from the lumbar fascia just lateral to the line where the middle and posterior lamellæ of the fascia blend. There is still, however, another lamella of the lumbar fascia—the anterior lamella. To display that part the dissector must divide the middle lamella vertically, close to its attachments to the tips of the transverse process, and transversely along the line of its attachment to the iliac crest. The middle lamella can then be turned laterally, and the posterior surface of the quadratus lumborum will be brought into view. When the lateral border of the quadratus lumborum muscle is displaced towards the median plane the anterior lamella of the lumbar fascia will be exposed. The dissector should place his finger upon its surface and trace it medially and laterally. Medially he will be able to follow it to, or to within a short distance of, the roots of the transverse processes of the vertebræ, and laterally he will find that it joins the remainder of the fascia some distance lateral to the union of the posterior and middle lamellæ. He must note, further, that, beyond the union of the three lamellæ, the lumbar fascia is continued into the transversus abdominis, and thus it is, through the lumbar fascia, that the transversus obtains its origin from the tips of the spines and transverse processes, and from the fronts of the transverse processes of the lumbar vertebræ. When the dissector has satisfied himself regarding the lamellæ of the lumbar fascia and their relation to the internal oblique and the transversus abdominis, he should carefully divide the anterior lamella longitudinally, and, introducing his finger through the incision, into the extra-peritoneal fatty tissue, he should scrape away the latter until he exposes the lower part of the kidney, below the level of the last rib; and the adjacent part of the colon, which lies along the lower and lateral part of the kidney. After that has been done the dissector of the abdomen ceases work till the body is re-turned, when he will re-examine the anatomy of the inguinal region in association with the formation of hernia, and afterwards proceed to the investigation of the abdominal cavity and its contents.

HERNIA.

The anatomy of the abdominal wall, in the regions where hernia most frequently occurs, is of such great importance to the surgeon that special attention must be paid to it by the dissector.

Hernia is the term applied to the abnormal protrusion, through the wall of the abdomen, of a viscus, or a part of a viscus, or of a part of a peritoneal fold which supports or is attached to a viscus.

It occurs most commonly where the peritoneal sac, or a diverticulum of the peritoneal sac, was prolonged through the abdominal wall at some period of intra-uterine development. The two situations in which such prolongations are always present are the inguinal region and the umbilicus; and it is stated that a small diverticulum is almost always met with in the subinguinal region, dipping into the mouth of the femoral canal of the femoral sheath. Those three regions, therefore, are the situations in which hernia is most often met with, and it is asserted that the most important factor in the production of hernia is the presence of a more or less definite persisting diverticulum of the peritoneum.

The diverticulum which existed in the inguinal region was the processus vaginalis described on pp. 234, 235. That diverticulum passed obliquely through the wall of the abdomen, producing the inguinal canal; and, although the diverticulum disappears, the canal made by its passage may be looked upon, to a certain extent, as a source of weakness to the part of the wall through which it runs. The weakness, however, is more apparent than real, for the canal is so oblique in the adult that its abdominal opening, *the abdominal inguinal ring*, is one and a half inches distant from its superficial opening, the *subcutaneous inguinal ring*; the opening is therefore valvular, and the intra-abdominal pressure, forcing the posterior wall against the anterior wall, tends to close the canal; moreover, the constituent parts of the anterior and posterior walls are so arranged that weakness of one wall is compensated for by strength in the opposite wall. The dissector should now proceed to demonstrate the truth of these statements by making a special dissection of the inguinal region on the left side of the body, which has been kept intact for the purpose.

Dissection.—Begin by reflecting the aponeurosis of the external oblique. Make a vertical incision through it, parallel to the lateral border of the rectus abdominis, and carry the incision downwards on the medial side of the superior crus of the subcutaneous inguinal ring. The aponeurosis can then be thrown downwards and laterally; and, at the same time, the subcutaneous ring is preserved. The internal oblique, the cremaster,

and falx inguinalis should now be cleaned, and their precise relations to the spermatic cord studied. Notice that the fleshy lower border of the internal oblique overlaps the lateral part of the cord, whilst, towards the outlet of the inguinal canal, the falx inguinalis lies behind the cord. Next, replace the aponeurosis of the external oblique, and introduce the point of the forefinger into the subcutaneous ring and press directly backwards. Note that the finger rests either upon the lig. inguinale reflexum, which lies anterior to the falx inguinalis, or, if the reflex inguinal ligament is absent, upon the falx inguinalis itself; that, in fact, the ligament and the falx and the fascia transversalis intervene between the finger and the extra-peritoneal fatty tissue and the peritoneum. The lower part of the internal oblique muscle should now be separated from the transversalis by insinuating the handle of the knife between them. When that is done, divide the internal oblique close to the inguinal ligament, and throw it medially. At the same time, make a longitudinal incision through the cremaster muscle, and turn it aside from the surface of the cord.

All further dissection must be effected from the inside. Divide the abdominal wall horizontally, from side to side, at the level of the umbilicus. When the lower part is raised and its posterior aspect is examined three peritoneal folds are seen—the *plicæ umbilicales*—a median and two lateral. In the median fold lies the *middle umbilical ligament* or urachus, which descends from the umbilicus to the apex of the urinary bladder, and in each lateral fold is the obliterated portion of the umbilical branch of the hypogastric artery of the corresponding side. Each lateral fold, with the contained obliterated artery, descends from the umbilicus to the side of the bladder if the latter is distended, and to the side wall of the pelvis if the bladder is empty. The lower part of each lateral fold lies on the posterior surface of the abdominal wall, a short distance to the medial side of the abdominal inguinal ring. Still more lateral on each side, close to the abdominal inguinal ring, is another fold, caused by the inferior epigastric artery as it ascends to the posterior aspect of the rectus abdominis.

By means of the folds three fossæ are mapped out on each side of the middle line above the inguinal ligament; they are termed the *supravesical*, the *medial* and *lateral inguinal fossæ*, and they are regarded as determining, to some extent, hernial protrusions in the inguinal region. The supravesical fossa lies between the middle umbilical fold and the lateral umbilical fold; the subcutaneous inguinal ring is in front of its lower part, separated from it by the most medial part of the posterior wall of the inguinal canal. The medial inguinal fossa, narrow but frequently very deep, lies between the lateral umbilical fold and the fold containing the inferior epigastric artery. It is behind that part of the posterior wall of the inguinal canal which is formed by the transversalis fascia only. The lateral inguinal fossa lies to the lateral side of the fold formed by the inferior epigastric artery, and its lowest, medial, and deepest part corresponds with the abdominal inguinal ring.

Having determined these points, the dissector can proceed as follows:—Divide the lower part of the abdominal wall in a vertical direction along the linea alba, from the umbilicus to the

pubes. Make the incision a little on one side of the middle umbilical ligament, and, when approaching the pubic symphysis, be careful not to injure the urinary bladder, which may project upwards above the symphysis. When the left flap is thrown downwards and laterally, it may be possible to detect the position of the abdominal inguinal ring, from the fact that in some cases the peritoneum is slightly dimpled into it. Now strip the peritoneum from the flap as far down as the inguinal ligament. That can be easily done with the fingers, as the connection of the peritoneum with the extra-peritoneal fatty tissue is very slight. Next, separate the extra-peritoneal fatty tissue from the fascia transversalis with the handle of the knife, proceeding with great care as the inguinal ligament is approached. The *abdominal inguinal ring*, or the inlet of the inguinal canal, is now seen from within. From that point of view the opening is more like a vertical slit in the fascia transversalis than a ring. Its lower and lateral margin will be seen to be specially strong and thick. Note the inferior epigastric artery passing upwards and medially, close to its medial margin. Further, observe the ductus deferens and the spermatic vessels entering it; the former, as it disappears into the canal, hooks round the inferior epigastric artery. Introduce the tip of the little finger into the opening and push it gently along the line of the inguinal canal. Whilst the finger is still in the opening raise the flap of the abdominal wall and look at it from the front, a very striking demonstration of the internal spermatic fascia will then be obtained.

If the dissection is satisfactorily completed the student will be able to note that the canal possesses (1) an inlet, the abdominal inguinal ring; (2) a floor formed laterally by the upper concave aspect of the inguinal ligament and medially by the lacunar ligament (Gimbernati); (3) an anterior wall; (4) a posterior wall; (5) an exit, the subcutaneous inguinal ring. A roof can scarcely be said to exist, for the anterior and posterior walls are in contact above, but arching above the lateral part of the canal are the lower borders of the internal oblique and the transversus abdominis. He should note also that there are three portions of the anterior wall and three portions of the posterior wall. At the medial end of the anterior wall lies the subcutaneous inguinal ring, covered, and to a certain extent closed, by the intercrural fibres descending on the spermatic cord. Immediately to the lateral side of the subcutaneous ring the anterior wall is formed by the aponeurosis of the external oblique only, and at its lateral end the anterior wall is composed of the external oblique aponeurosis and the lower fibres of the internal oblique muscle: the anterior wall, therefore, is weakest at its medial and strongest at its lateral exteemity. The posterior wall, on the contrary, is strongest

at its medial end and weakest at its lateral end. At its medial end, behind the subcutaneous inguinal ring, it is three layers thick, the layers, from before backwards, being the lig. inguinale reflexum, the falx inguinalis, and the transversalis fascia. More laterally, opposite the region where the anterior wall consists of external oblique aponeurosis alone, the posterior wall is formed by the transversalis fascia and the

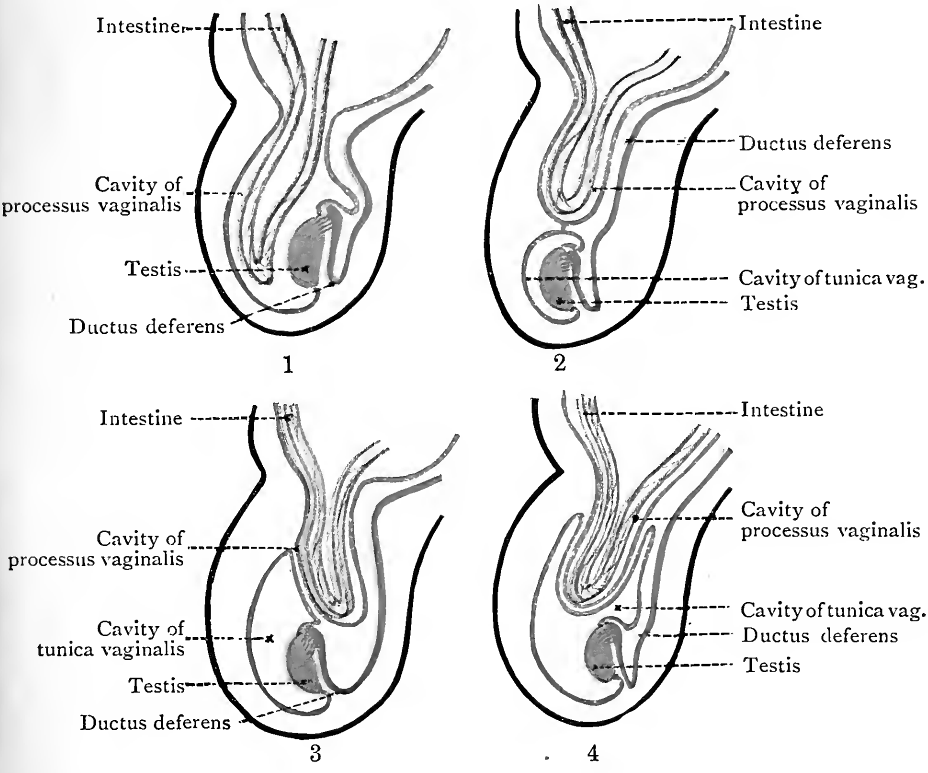

FIG. 115.—Diagram illustrating different forms of scrotal herniæ.

falx inguinalis, and still more laterally, where the anterior wall is formed by both external oblique aponeurosis and internal oblique muscle, the posterior wall is represented by transversalis fascia only. The walls of the canal are well adapted, therefore, to resist the effects of intra-abdominal pressure. The student must remember, however, that, for practical purposes, in association with the formation of hernia, the contents of the abdomen may be looked upon as being of a fluid or semifluid nature; consequently, if a portion of the abdominal contents happens to slip through the abdominal

inguinal ring, into a persisting, though shrunken, processus vaginalis, the action of the abdominal pressure will, thenceforth, tend to distend the inguinal canal and force the abdominal contents further and further along it, until they eventually protrude through the subcutaneous inguinal ring. The coverings of such a hernia will naturally be the constituent parts of the abdominal wall in the inguinal region: that is, from within outwards, (1) peritoneum, (2) extra-peritoneal fat, (3) internal spermatic portion of transversalis fascia, (4) cremasteric fascia, (5) external spermatic fascia, (6) superficial fascia, and (7) skin. A hernia which travels obliquely through the abdominal wall, along the line of the inguinal canal, is called an *oblique inguinal hernia*, and, as the neck of the hernial sac lies to the lateral side of the inferior epigastric, it is called a *lateral inguinal hernia.* If the cavity of the persisting processus vaginalis, into which the hernia has passed, is still continuous with the cavity of the tunica vaginalis, the herniated viscus or peritoneal fold will enter the tunica vaginalis of the testis; but, if the cavity of the upper part of the processus vaginalis has been separated from that of the lower part by the formation of an oblique or transverse septum, the upper part of the processus, with its contained hernia, may be forced downwards either anterior or posterior to the lower part, or the lower end of the upper part may invaginate the upper end of the lower part. Herniæ differentiated from each other by the relationship which the upper part of the processus, containing the herniated viscus, bears to the lower part, the tunica vaginalis, are described by surgeons under special names which the student will find fully explained in manuals of surgery. There are, however, other forms of inguinal hernia which do not pass through the abdominal inguinal ring, but through the posterior wall of the canal, on the medial side of the inferior epigastric artery, between it and the obliterated part of the umbilical artery, or, still more medially, between the obliterated part of the umbilical artery and the lateral border of the rectus. Such herniæ, because they do not pass obliquely along the inguinal canal but more directly through its posterior wall, are called by the surgeon *direct inguinal herniæ.* As there are no congenital diverticula of the peritoneum in these regions such herniæ must be due either to the slow distension of weak points in the posterior wall of the inguinal canal, under the

influence of the intra-abdominal pressure, or to the instant rupture of such points when the pressure is suddenly increased. After a pouch of the posterior wall, containing gut, has been protruded into the canal, or after a portion of the peritoneal sac containing gut has been forced through the posterior wall into the canal, the action of the abdominal pressure will tend to force the protrusion along the line of least resistance, which is usually along the canal to the subcutaneous inguinal ring. The coverings of the direct hernia will differ according to whether the hernia has torn the posterior wall or forced it forwards as a covering, and, in the latter case, according to whether the hernia has passed from the medial inguinal pouch, between the inferior epigastric artery and the obliterated part of the umbilical artery, or through the supravesical pouch, at the medial side of the obliterated artery. The coverings of the hernia passing from the medial inguinal pouch will be the same as those of the oblique hernia, except that transversalis fascia will take the place of internal spermatic fascia; but if the hernia passes from the supravesical pouch, on the medial side of the obliterated part of the umbilical artery, it will push before it the falx inguinalis, it will enter the canal below the upper border of the cremasteric fascia, and it will receive no sheath from the latter fascia; from within outwards, therefore, its anatomical coverings will be—(1) peritoneum, (2) extra-peritoneal fat, (3) transversalis fascia, (4) falx inguinalis, (5) external spermatic fascia, (6) superficial fascia, (7) skin. The student should understand also that whilst it is commonly believed that oblique herniæ are usually due to the persistence of a portion of the processus vaginalis, there is no anatomical reason why a new peritoneal sac should not be formed in the region of the lateral inguinal fossa, that is, in the region of the abdominal inguinal ring, as easily as in other regions. If such a pouch were formed it would pass along the line of the canal, its coverings would be similar to those of a hernia which had passed into the upper persisting part of the processus vaginalis, and its relationship to the tunica vaginalis would depend largely upon the size of the latter sac, that is, upon how much of the lower part of the original processus remained unobliterated, and upon the more anterior or more posterior position of the upper end of the tunica vaginalis.

Femoral Hernia.—This consists in the protrusion of some abdominal contents from the abdominal cavity into the region

of the thigh. In its descent it passes *behind* the inguinal ligament, along the *femoral canal* of the femoral sheath. It is consequently mainly the duty of the student who is engaged in the dissection of the lower limb, and within whose domain the femoral sheath lies, to investigate the anatomical connections of this variety of hernia (Vol. I. p. 243). Still, it is essential that the dissector of the abdomen should examine,

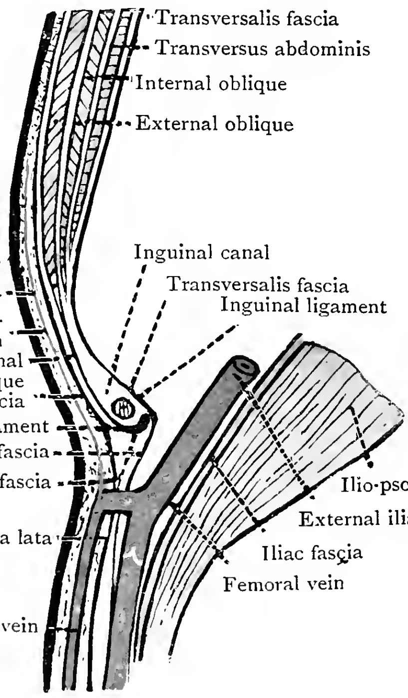

FIG. 116.—Diagram of a Sagittal Section through the lower part of the Anterior Wall of the Abdomen in the region of the Inguinal Canal.

from its abdominal aspect, the *femoral ring*, or aperture of communication between the femoral canal and the abdominal cavity, and give the dissector of the lower limb an opportunity of doing so likewise.

The *femoral ring* is placed immediately below the inguinal ligament, in the interval between the external iliac vein and the base of the lacunar ligament (Gimbernati) and therefore below the inguinal canal. If the peritoneum is still in position at that point it may exhibit a slight dimpling or depression as it passes over the ring. Strip the peritoneum from the greater part of the iliac fossa. The extra-peritoneal fatty

tissue, as it stretches across the femoral ring, will be observed to be denser, stronger, and more fibrous than elsewhere. A special name is applied to that small portion of the extra-peritoneal fatty tissue. Seeing that it is applied to the ring in such a manner as to close the femoral canal at its abdominal end, it is called the *septum femorale.*

> ***Dissection.***—With the handle of the knife dissect away the extra-peritoneal fatty tissue in the area from which the peritoneum has been displaced. The *fascia iliaca* covering the iliacus and psoas muscles will then be exposed, and the dissector should note that the external iliac vessels lie *inside* and not *outside* that fascia.

The dissector is now in a position to study the manner in which the *femoral ring* is formed. He should follow the fascia iliaca and the fascia transversalis towards the inguinal ligament. If the dissection has been carefully performed it will be obvious that, to the lateral side of the external iliac vessels, these two fasciæ become directly continuous with each other, and, further, that along the line of union they are both firmly attached to the inguinal ligament. It is evident, then, that no hernial protrusion could leave the abdominal cavity behind the inguinal ligament lateral to the iliac vessels.

In the region of the iliac vessels the arrangement of the fascia will be found to be different. There the fascia iliaca is carried downwards behind the vessels, whilst the fascia transversalis is prolonged downwards in front of the vessels and behind the inguinal ligament (Fig. 116). In the region of the thigh the two fasciæ form a funnel-shaped sheath for the femoral artery and vein, and for some lymph vessels ascending to the abdomen. The sheath is divided into three compartments by two antero-posterior partitions. The femoral artery occupies the lateral compartment, and the vein the intermediate compartment, whilst the medial compartment, called the *femoral canal,* is occupied by the lymph vessels and, sometimes, by a small lymph gland.

An essential difference between the compartments is that whilst the lateral two are completely filled up by the artery and vein, the femoral canal is much wider than is necessary for the passage of its contents. Gauge the width of the femoral ring by introducing the point of the little finger. It is readily admitted within the opening. Here, then, is a source of weakness to the abdominal wall, and one which is

greater in the female than in the male, seeing that the distance between the iliac spine and pubic tubercle is proportionally greater in the female, and, in consequence, the femoral ring wider.

When the finger is within the ring, mark the structures which surround it—*anteriorly*, the inguinal ligament, with the spermatic cord or the round ligament of the uterus; *posteriorly*, the ramus of the pubis, giving origin to the pectineus muscle, which is covered by the pectineal portion of the fascia lata; *medially*, the sharp, crescentic free border of the lacunar ligament; and *laterally*, the external iliac vein.

It is still more necessary to note the relations of the blood-vessels to the femoral ring. The *external iliac vein* has been seen to lie to its lateral side. The *inferior epigastric artery*, as it ascends on the posterior aspect of the abdominal wall, is close to the upper and lateral margin of the ring, and it sends its *pubic branch* medially in front of the ring. More important than any of those relations is the relation of the *obturator artery*, when it takes origin from the inferior epigastric. That anomalous vessel may adopt one of three courses:—(1) It may follow the course of the pubic artery, an enlarged form of which it in reality is, and pass medially *in front* of the ring, and then descend along its *medial* margin. In that case, the ring is surrounded on all sides, except posteriorly, by important vessels. (2) It may pass downwards and backwards across the femoral ring. (3) It may run downwards between the ring and the external iliac vein (*vide* Vol. I. p. 244).

Medial to the femoral sheath the passage of a hernial protrusion behind the inguinal ligament is effectually prevented by the lacunar ligament.

Femoral hernia is more common in females, and inguinal hernia in males; and for the very evident reason that, in the female, the femoral canal is relatively larger, whilst in the male the passage of the spermatic cord weakens the inguinal region more than the passage of the small round ligament of the uterus in the female.

Umbilical Hernia.—If the dissector examines the umbilicus he will find that he is dealing with a dense fibrous ring which is fused with the remains of the umbilical vein and the remains of the obliterated parts of the umbilical arteries and the urachus, the whole forming a dense nodule of fibrous

tissue closely connected with the superjacent skin. The umbilicus marks the position where, during a large part of intra-uterine life, the peritoneal cavity was prolonged through the abdominal wall into the root of the umbilical cord, which attached the fœtus to the mother. For a considerable time a portion of the gut lies in the extra-abdominal sac in the root of the umbilical cord, but, before birth, it is withdrawn into the abdomen and the sac shrinks and disappears. If a remnant of the sac persists in the substance of the abdominal wall, after birth, the wall is weakened and a portion of the abdominal contents may be forced into the diverticulum, causing its distension and producing an umbilical hernia. The anatomical coverings from within outwards would be—(1) peritoneum, (2) aponeuroses of the abdominal wall equivalent to the stretched linea alba, (3) superficial fascia, (4) skin.

If the fœtal condition persists until birth a portion of the gut lies in the umbilical cord, separating the three vessels; and more than one case has occurred in which the bowel has been cut when the cord was divided after the birth of the child.

ABDOMINAL CAVITY.

When the dissector has completed his examination of the regions where hernia most commonly occurs he should proceed to study the abdominal cavity and its contents.

Dissection.—The lower half of the abdominal wall has already been divided along the median plane; now carry an incision upwards, from the umbilicus to the xiphoid process of the sternum, immediately to the left of the median plane, and throw the two flaps thus formed upwards and laterally over the lower margins of the thorax. The abdomen will then be fully opened up and the examination of its contents may commence. As the flap on the right side is turned upwards a strong fibrous cord will be noticed extending from the umbilicus to the inferior surface of the liver. It is the *ligamentum teres* of the liver and is the remains of the umbilical vein of the foetus. As it ascends towards the liver, it recedes from the posterior surface of the anterior abdominal wall, taking with it a fold of peritoneum termed the falciform ligament of the liver.

Shape and Boundaries of the Abdominal Cavity.—The abdominal cavity is ovoid in shape, and its vertical diameter is the longest. *Superiorly*, it is roofed by the dome-

shaped *diaphragm*, which presents a deep concavity towards the abdomen. *Inferiorly*, its floor is formed by the *pelvic diaphragm*, consisting of the levatores ani and the coccygei muscles. The floor also is concave towards the abdominal cavity. Neither the roof nor the floor is complete and unbroken. The diaphragm is perforated by certain structures which pass between the thorax and the abdomen. The continuity of the pelvic diaphragm is broken by the passage of certain structures between the pelvic division of the abdominal cavity and the perineum. The upper part of the abdominal cavity extends upwards for a considerable distance under the shelter of the lower ribs and their costal cartilages. The protection which is thus afforded to the viscera in that portion of the cavity is most complete laterally and posteriorly. Anteriorly, a wide Λ-shaped gap is left between the costal cartilages of the opposite sides as they ascend towards the sternum. The level to which the costal arches descend on each side varies greatly in different subjects, but, in the great majority of cases, a narrow belt of abdominal wall, from one to two inches wide, is left between the lower border of the chest wall and the highest point of the iliac crest. The only skeletal support of that part of the wall lies behind and is provided by the lumbar part of the vertebral column.

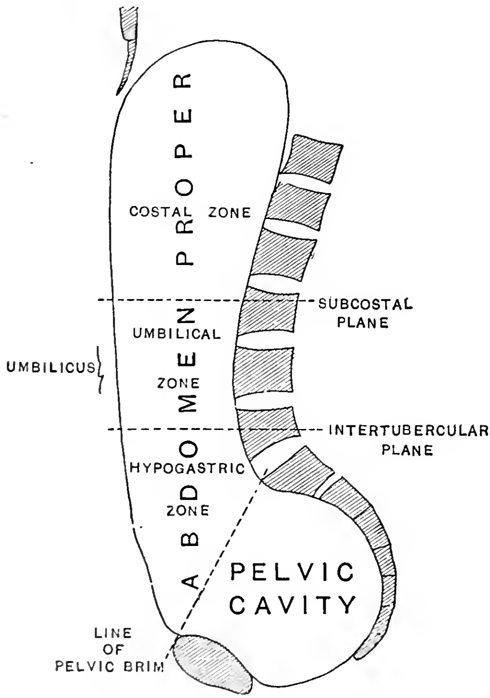

FIG. 117.—Outline of the Abdominal Cavity as seen in median section. The planes of subdivision are indicated by dotted lines.

At a lower level, the expanded iliac bones give support to the abdominal walls posteriorly and laterally, whilst, in the lowest part of the abdomen, the pubic, ischial, sacral, and

coccygeal bones form very complete bony boundaries for the cavity.

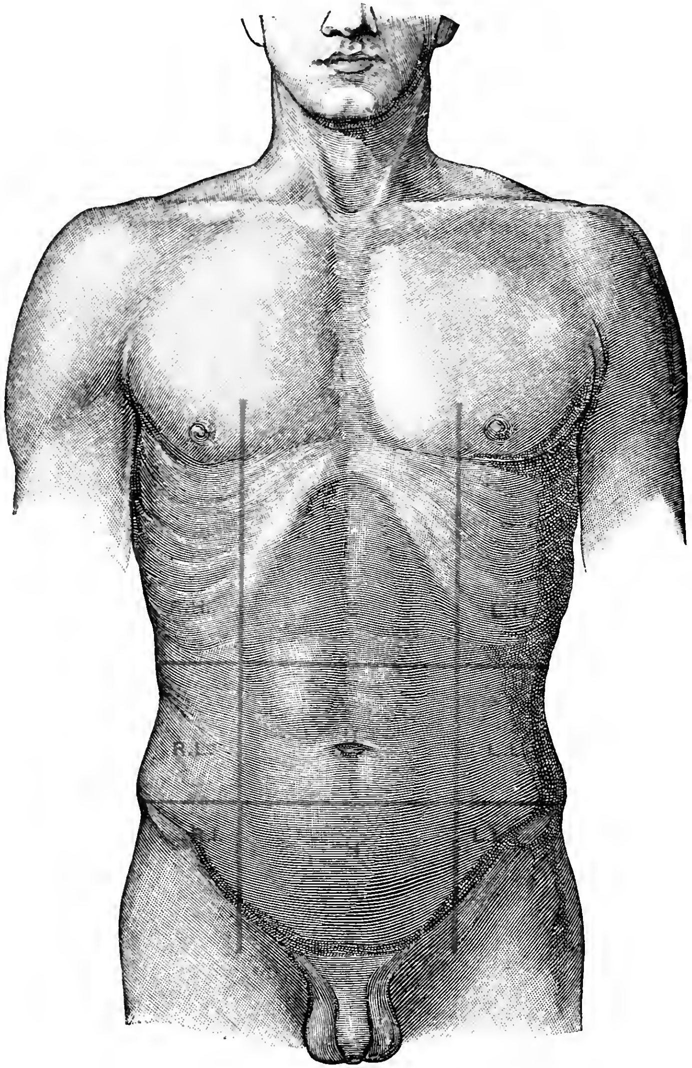

FIG. 118.—Planes of subdivision of the Abdominal Cavity.

R.H. Right hypochondrium.
R.L. Right lumbar region.
R.I. Right iliac region.
E. Epigastric region.
U. Umbilical region.
H. Hypogastric region.
L.H. Left hypochondrium.
L.L. Left lumbar region.
L.I. Left iliac region.

Whilst the abdominal cavity, therefore, is very fully protected, posteriorly and laterally, by skeletal parts, the anterior

wall is almost entirely formed by the muscles and aponeuroses which have already been dissected.

It is obvious, however, that the roof, floor, and the greater part of the abdominal wall are composed of muscular structures, the contraction of which diminishes the capacity of the cavity and subjects the contained viscera to compression.

Subdivision of the Abdominal Cavity.—In order that the exact positions of the numerous and diverse contents of the abdomen may be accurately defined it is necessary to divide the cavity into regions. In the first place the cavity of the abdomen is divided into two principal parts, the *abdomen proper* and the *pelvis minor.* The plane of separation between the two is an imaginary plane which lies at the level of the upper aperture of the pelvis minor, extending from the front of the promontory of the sacrum to the upper border of the symphysis pubis. The two main parts of the cavity are not in direct line with one another. The long axis of the abdomen proper is nearly vertical; that of the pelvis minor is very oblique, and is directed backwards and downwards. The difference of direction is so great (see Fig. 117), and the difference in size is so marked, that the pelvis minor has the appearance of a large recess which projects backwards and downwards from the lower part of the abdomen proper.

The abdomen proper is still further subdivided by means of four arbitrary planes of section. Two of these pass through the body in a horizontal direction, and two in a vertical direction. The former are termed the *subcostal* and the *intertubercular planes* of subdivision, and the position of each is determined as follows:—A horizontal line, drawn around the body at the level of the most dependent parts of the tenth costal arches, indicates the position of the *subcostal plane.* A second line, drawn around the body at the level of the highest parts of the iliac crests, which can be seen from the front, gives the level of the *intertubercular plane.*

The highest part of each iliac crest which can be seen from the front lies about 50-60 mm. (two to two and a half inches) behind the anterior superior spine of the ilium. Its position is indicated by the junction of the lateral outline of the trunk with the outline of the hip bone at the point where a prominent tubercle juts out from the external lip of the iliac crest; hence the term intertubercular plane.

The two horizontal planes map out the abdomen into

three districts or zones, which are termed, from above downwards—(1) the *costal*, (2) the *umbilical*, and (3) the *hypogastric zone*.

The two vertical planes of subdivision are called the *right* and *left lateral planes*. Each corresponds, on the surface, to a perpendicular line reared from the inguinal ligament at the

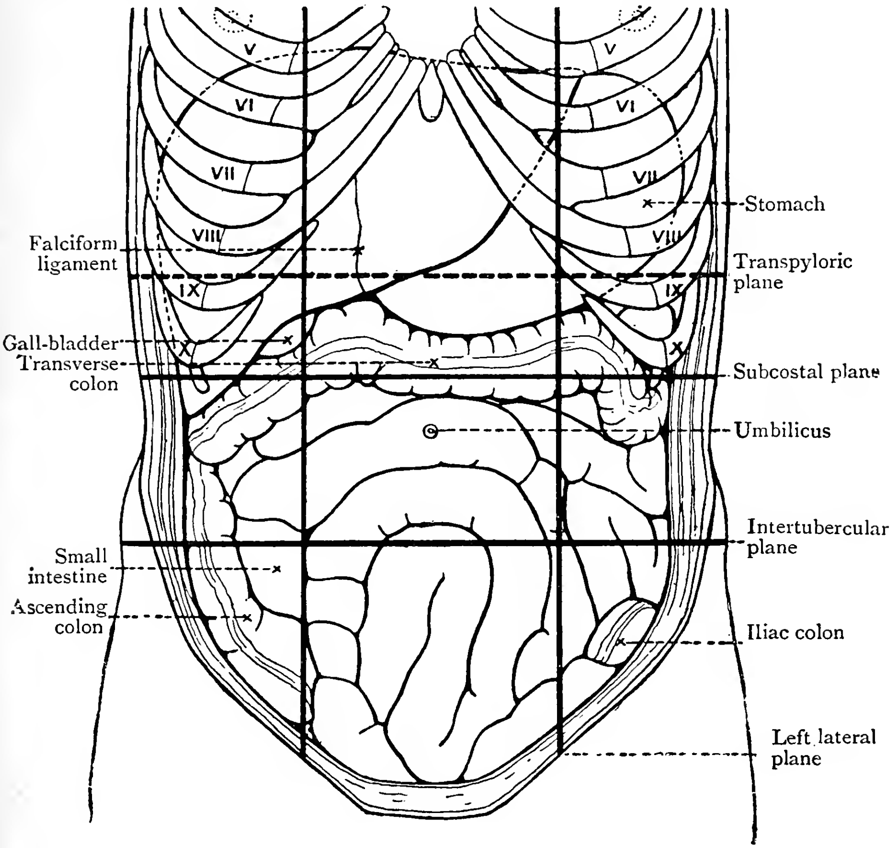

FIG. 119.—The Abdominal Viscera, as seen from the front, after removal of the greater omentum. The dark lines indicate the subdivision of the abdominal cavity. (Birmingham.)

midpoint between the symphysis pubis and the anterior superior spine of the ilium.

By the lateral planes, each of the three zones determined by the horizontal planes of section is subdivided into three parts.

The costal zone is mapped off into a central *epigastric region* and a *right* and a *left hypochondriac region*; the umbilical

zone, into a central *umbilical region* and a *right* and a *left lumbar region* ; and the hypogastric zone, into a central *hypogastric region* and a *right* and a *left iliac region.*

Contents of Abdomen Proper.—The following structures lie within the upper section of the abdominal cavity.

1. Abdominal part of the alimentary canal. { Stomach. Small intestine. Large intestine.
2. Glands situated outside the walls of the alimentary canal and pouring their secretions into it. { Liver, with its gall-bladder or reservoir. Pancreas.
3. The spleen.
4. The two kidneys, the ureters, and the two suprarenal glands.
5. Lymph glands, lymph vessels, the cisterna chyli, and the commencement of the thoracic duct.
6. The abdominal aorta, with its various visceral and parietal branches.
7. The inferior vena cava and its tributaries, and the commencements of the vena azygos and vena hemiazygos.
8. The vena portæ and its tributaries.
9. The lumbar plexuses of nerves.
10. The abdominal portions of the sympathetic nervous system.
11. The peritoneal membrane, which lines the cavity and invests the viscera.

When the abdominal cavity is opened, a very partial view of the contained viscera is obtained, so long as they are left undisturbed. On the right side of the costal zone the sharp margin of the liver may be observed, projecting slightly below the ribs, whilst, opposite the ninth costal cartilage, the fundus of the gall-bladder is seen, peeping out from under cover of the liver, and projecting slightly beyond its anterior border. In the same zone, to the left of the liver, a portion of the stomach is visible, and extending downwards from the greater curvature or anterior border of the stomach is a broad apron-like fold of peritoneal membrane, called the *greater omentum.* The greater omentum usually contains a quantity of fat in its meshes, and is spread out like an apron, so as to hide from view the viscera which occupy the lower two zones. Sometimes, however, the greater omentum is narrow and short; or it may be turned more or less completely upwards or to one side. In either case some of the coils of the small intestine will be seen, and also, in all probability, those parts of the large intestine which occupy the right and left iliac fossæ. The part lying in the right iliac fossa is called the *cæcum,* whilst the part situated in the left iliac fossa is the *iliac colon.* It may also chance that the urinary bladder is full, in which

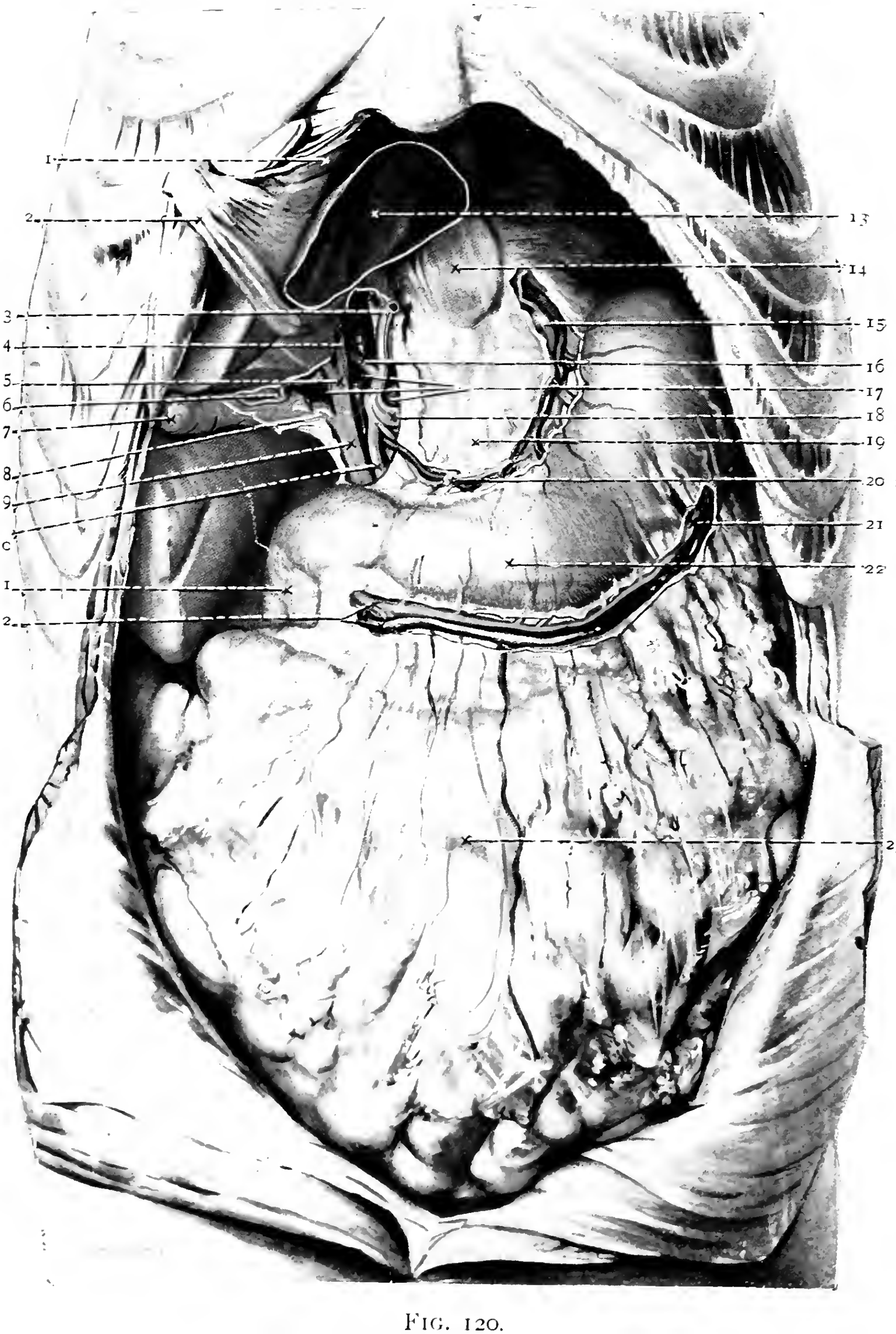

FIG. 120.

PLATE VII

Fig. 120.—View of the Interior of the Abdomen.

The upper part of the anterior wall of the abdomen has been removed. The lower part has been divided in the median plane and turned aside.

The greater part of the left lobe of the liver has been removed and the pyloric part of the stomach has been displaced downwards.

The liver is seen in the upper and right portion of the abdominal cavity, with the gall-bladder and the cystic artery on the inferior surface of its right lobe.

The round ligament of the liver and the falciform ligament have been pulled over the right costal arch and have been fixed to the wall of the thorax. From the point of attachment the round ligament runs downwards and backwards to the umbilical fossa of the liver, and the falciform ligament extends backwards to the anterior and upper surfaces of the liver.

Below and to the left of the liver is the stomach, which is connected to the liver by a fold of peritoneum called the lesser omentum. From the lower border of the stomach the greater omentum hangs down in front of the contents of the lower part of the abdominal cavity.

The anterior layer of the lesser omentum has been removed along the upper or lesser curvature of the stomach, to display the right and left gastric vessels, which lie between the two layers; and it has been removed also along the right or free margin of the omentum, to display the hepatic artery and its branches, the portal vein and the bile duct, the cystic duct and the common hepatic duct.

By the displacement downwards of the pyloric end of the stomach, the gastro-duodenal branch of the hepatic artery has been brought into view.

The anterior layer of the greater omentum has been removed along the lower part of the greater curvature of the stomach to display the right and the left gastro-epiploic vessels.

1. Falciform ligament.
2. Ligamentum teres.
3. Left hepatic artery.
4. Left hepatic duct.
5. Common hepatic duct.
6. Cystic artery.
7. Fundus of gall-bladder.
8. Cystic duct.
9. Bile duct.
10. Gastro-duodenal artery.
11. Duodenum, descending part.
12. Right gastro-epiploic vessels.
13. Face of section of left lobe of liver.
14. Caudate lobe, seen through lesser omentum.
15. Left gastric artery.
16. Right hepatic artery.
17. Portal vein.
18. Hepatic artery.
19. Lesser omentum.
20. Right gastric vessels.
21. Left gastro-epiploic artery.
22. Stomach.
23. Greater omentum.

case its apex will be observed projecting above the pubes. Lastly, in pregnant females the gravid uterus will be visible, reaching a height which varies with the period of gestation.

Raise the greater omentum and turn it upwards over the inferior margin of the thorax. By that proceeding the coils of the small intestine will be exposed, and a part of the large intestine, the *transverse colon*, which extends across the cavity of the abdomen will also be brought into view. It is attached to the posterior part of the greater omentum.

Note that all the viscera which have been seen are covered by a smooth glistening membrane, *the peritoneum*. That membrane forms the immediate boundary of a space, *the peritoneal cavity*, which has been opened into by the reflection of the anterior wall of the abdomen. The dissector should recognise that under normal circumstances the peritoneal cavity is merely a potential cavity, and that it becomes an actual cavity only when the surgeon or dissector pulls its walls apart when opening into it, or when its walls are forced apart by abnormal collections of fluid or gas.

Replace the greater omentum and commence a fuller consideration of the general position, relations, and connections of the viscera by examining the general position of the liver.

Hepar.—The liver is the large, reddish-brown organ which occupies a large part of the upper portion of the abdomen, where it lies in the epigastric region and both hypochondriac regions. A very large portion of its surface is in contact with the diaphragm, which separates it from the contents of the lower part of the thorax. The inferior border of its anterior surface crosses the subcostal angle from above downwards and to the right, and continues to the right, either along or immediately below the right costal arch. Opposite the tip of the ninth right costal cartilage the fundus of the gall-bladder projects from beneath it. Pass the hand over the anterior and upper surfaces of the liver, and note that they are connected to the anterior abdominal wall and to the diaphragm, respectively, by a fold of the peritoneal lining of the abdomen which is called the falciform ligament. Raise the inferior margin of the liver and note that the lower and posterior surfaces of the liver are connected to the stomach by a fold of peritoneum called the *lesser omentum*. A more detailed account of the attachments of the liver is given on p. 365.

Dissection.—**Fasten the lower border of the anterior surface of the liver to the right costal arch and examine the stomach.**

Ventriculus.—The stomach is a pear-shaped organ which lies in the left hypochondriac and epigastric regions, partly below and partly to the left side of the liver. Its long axis runs obliquely and is curved upon itself, the base or *fundus* of the organ being situated above, behind, and to the left, whilst the apex or *pylorus* lies lower, more anteriorly,

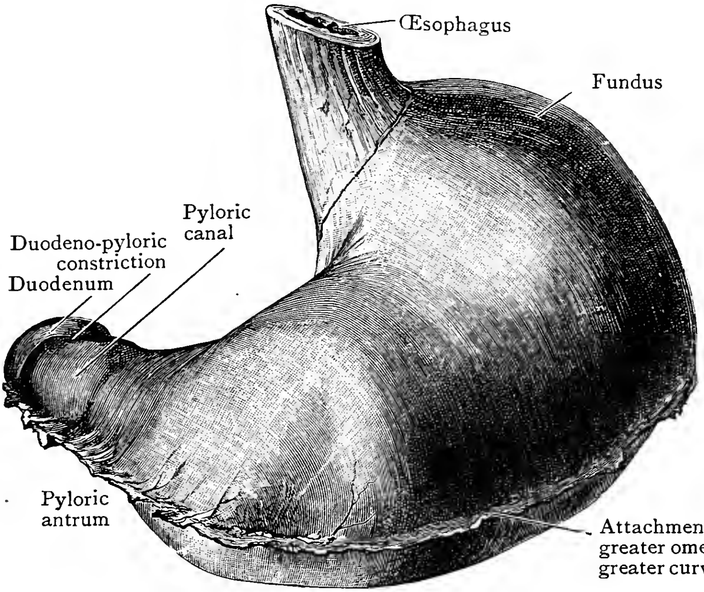

FIG. 121.—Stomach of a Child, two years of age, hardened *in situ* by formalin injection.

and more to the right. Traced from its highest to its lowest point, it runs first forwards and slightly downwards, then to the right, and finally slightly backwards to its junction with the duodenum or proximal portion of the small intestine. When the left lobe of the liver is pulled upwards and to the right the œsophagus will be found entering the stomach, a little to the right of the highest point of the fundus, at the *cardiac* or *œsophageal orifice*. From that point the two borders of the stomach can be traced to the pyloric end of the organ. The upper border or *lesser curvature* is much the shorter; it runs downwards and to the right in a fairly uniform curve. The *greater curvature* is much longer. First it ascends from the œsophagus to the highest point of the fundus. After crossing

the fundus it runs forwards and downwards with a marked convexity to the left; finally it runs to the right and slightly backwards with a convexity downwards. The second portion is frequently spoken of as the left lateral border and the last portion as the inferior border of the stomach; the junction of these two parts is commonly the lowest portion of the organ and, when the body is recumbent, it lies on a level with the tips of the tenth costal cartilages, but in the erect posture, and when the stomach is full it may descend to a much lower point, even to the level of the umbilicus or still lower. The dissector will find that the lesser curvature is attached to the lower and posterior surfaces of the liver by a fold of peritoneum which is called the *lesser omentum*. The part of the greater curvature immediately adjacent to the œsophagus is attached to the diaphragm by a peritoneal fold, the *gastro-phrenic ligament*; the descending part of the greater curvature is attached to the spleen by the *gastro-splenic ligament* (O.T. *gastro-splenic omentum*); and the lower part of the greater curvature is connected with the transverse colon by the *greater omentum*. The first of these connections can be demonstrated by pulling the stomach downwards, the second, by pulling it to the right, and the last, by raising the greater omentum, which hangs down from the lower border, and turning it upwards over the lower margin of the costal arch. The surfaces of the stomach are an anterior or superior and a posterior or inferior. The latter cannot be seen at the present stage of dissection; it rests on the stomach bed. The anterior is directed upwards and forwards; and the student should note that it is in relation to the left and above with the diaphragm, below with the anterior wall of the abdomen, in the region of the subcostal angle, and above and to the right with the lower surface of the liver.

The above account gives an indication of the general form, position, and relations of the stomach which are met with after death when the body is lying upon its back, but the student must realise that whilst the connections of the stomach are always the same, its size, form, and position vary with the amount of its contents, the stage of digestion, and the position of the body. A glance at Figs. 122, 123, 124, 125, which represent drawings of radiographs of stomachs in different conditions of distension, digestion, and position of the body,

PLATE VIII

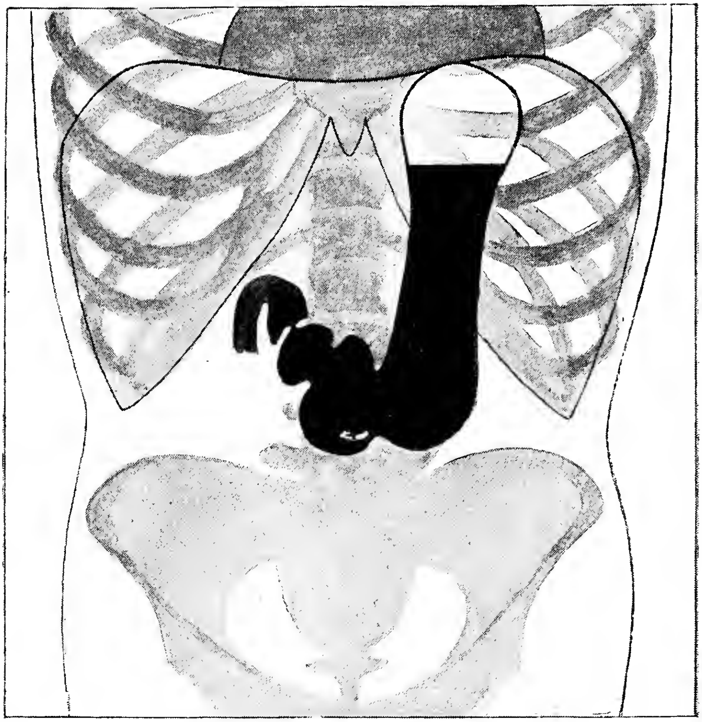

FIG. 122.

Drawing from radiograph of normal stomach as seen in the vertical position after an ordinary bismuth and barium meal containing two ounces of bismuth and two ounces of barium sulphate. It shows the depressions caused by peristaltic contractions towards the pylorus, and as these are constantly moving towards the pylorus they are not due to fixed anatomical constrictions, and are therefore omitted from the other plates. The pylorus and commencement of the duodenum are shown.

As the drawing was made orthodiagraphically, it is therefore to scale and not distorted. Drawing by A. F. Hertz, M.D., F.R.C.P.

PLATE IX

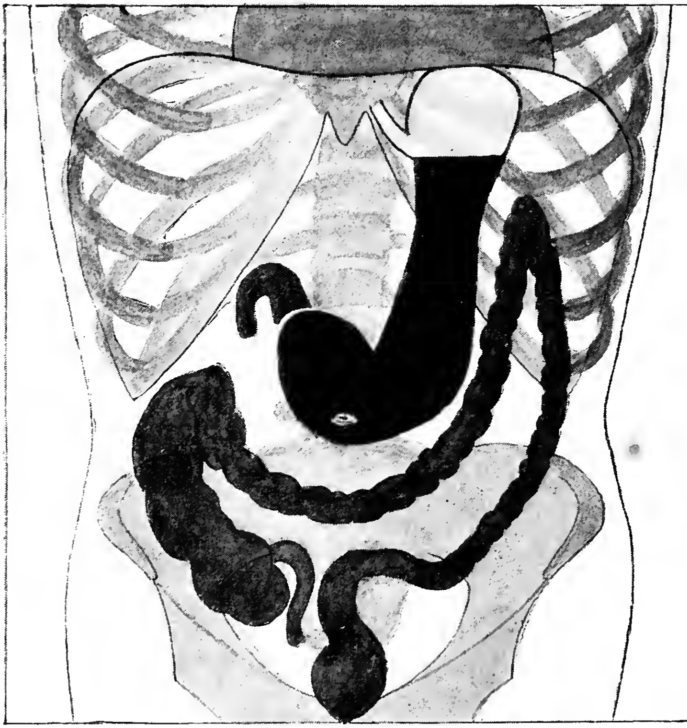

FIG. 123.

Drawing of radiograph of a normal stomach in the vertical position after an ordinary bismuth meal without the contractions seen in the preceding plate.

The lighter shadow is a composite drawing taken at varying periods after the meal, showing the appearance of the lowest part of the ileum, the cæcum, and large intestine as the bismuth was passing through.

The tracings were made orthodiagraphically, and are therefore to scale and not distorted. Drawing by A. F. Hertz, M. D., F. R. C. P.

PLATE X

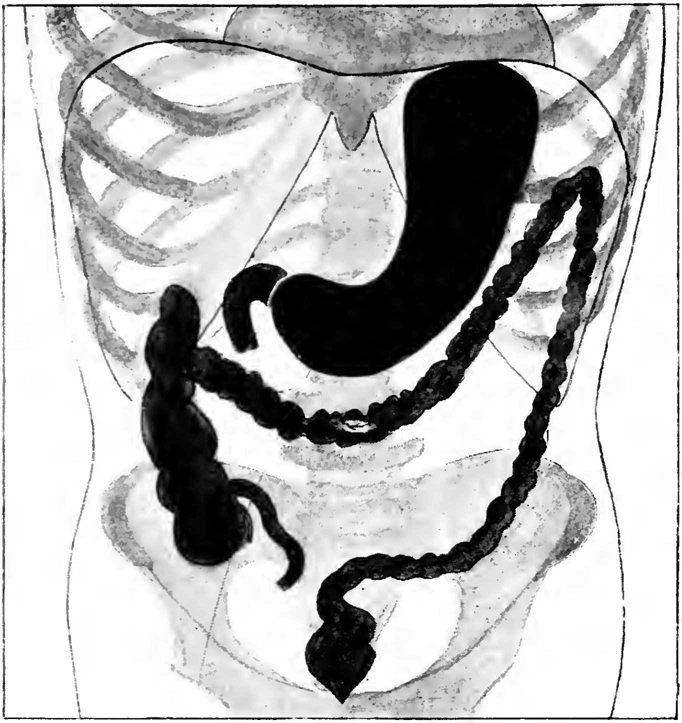

FIG. 124.

Drawing from tracing of radiograph of a normal stomach taken in the *horizontal position* immediately after an ordinary bismuth and barium meal.

The lighter shadow is a composite tracing of the ileum and large intestine taken as in Plate IX.

The tracings were made orthodiagraphically, and are therefore to scale and not distorted. Drawing by A. F. Hertz, M.D., F.R.C.P.

PLATE XI

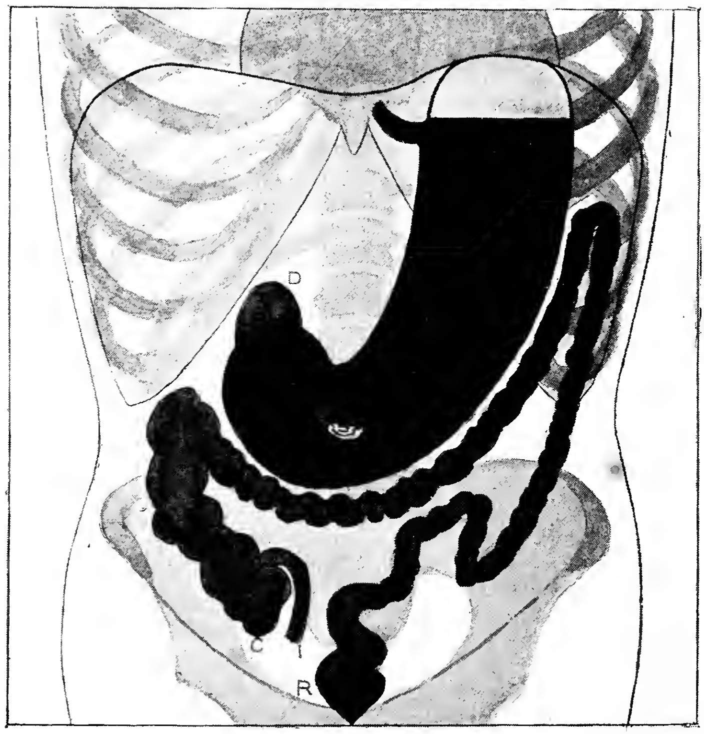

FIG. 125.

Drawing of a normal stomach as seen with X-Rays in the vertical position after an ordinary dinner with two ounces of barium sulphate added. D = the duodenum, and the light mark indicates the position of the umbilicus.

As in the previous plates the lighter shadow represents a composite tracing of the ileum (I), cæcum (C), large intestine, and rectum (R), taken at varying periods after. Note the additional loop at the commencement of the pelvic colon, often seen in normal individuals.

The drawings were made orthodiagraphically, and are therefore to scale and not distorted. Drawing by A. F. Hertz, M.D., F.R.C.P.

shows, at once, that whilst the position of the fundus remains constant, and that of the pylorus is relatively constant, the other parts of the organ vary considerably in size and position, and that the lowest part of the organ instead of remaining in the costal zone of the abdominal cavity frequently descends into the umbilical region, whilst Fig. 126 shows that the form of the stomach met with in dissecting-room subjects is also very variable. After examining the stomach the dissector should look for the spleen.

Lien (The Spleen).—If the spleen is of normal size and is

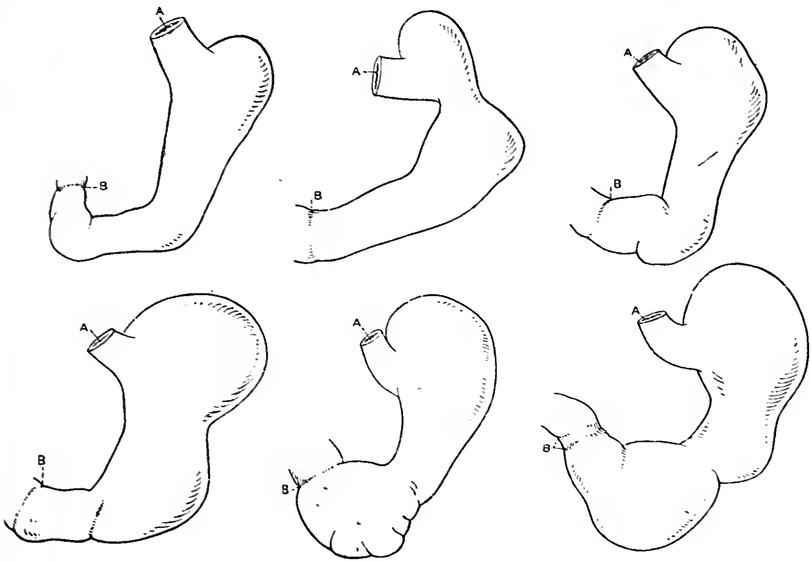

FIG. 126.—Anterior views of six Stomachs removed from dissecting-room subjects. A, Œsophagus; B, Pylorus.

lying in its normal position, it cannot be seen, when the abdominal organs are undisturbed, but it can easily be felt if the hand is passed backwards, round the left margin of the stomach, into the posterior part of the left hypochondriac region, and it can be brought into view by pulling the stomach towards the right side. When that has been done the spleen will be found to be attached to the stomach by a fold of peritoneum called the *gastro-splenic ligament* (omentum) and it is attached to the anterior surface of the left kidney, which can easily be felt, behind the spleen, by a fold of peritoneum called the *lieno-renal ligament.* The dissector should note that the lower end of the spleen is supported by

an angular bend of the large intestine, called the *left colic flexure*, and by a fold of peritoneum, the *phrenico-colic ligament*, which connects the left colic flexure with the lower surface of the diaphragm, at the level of the eleventh rib in the mid-axillary line.

Intestinum (The Intestine).—When the dissector has satisfied himself regarding the general position and attachments of the liver, stomach, and spleen, he should familiarise himself with the parts, position, and the attachments of the intestine. There are two main parts of the intestine, the

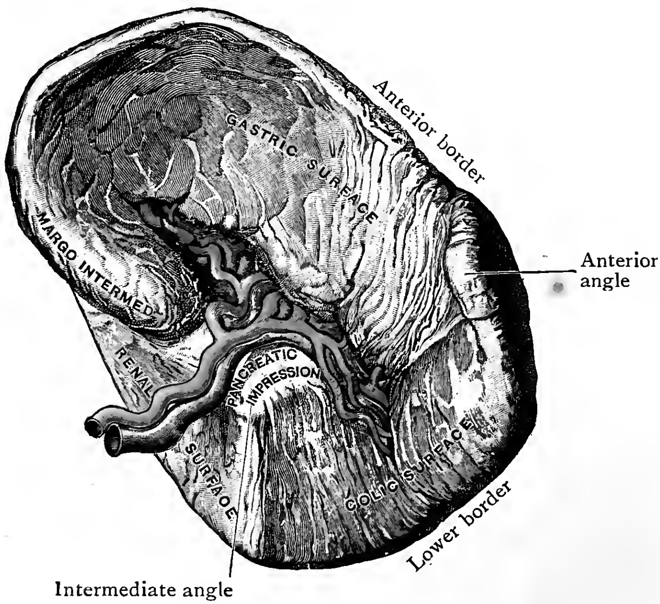

FIG. 127.—The Spleen (visceral aspect).

small and the large. They cannot, however, be distinguished from each other by size alone, for the calibre of each part varies according to the state of contraction or relaxation of its muscular walls.

The small intestine commences at the pyloric end of the stomach, under cover of the liver, which must be raised to expose it. The termination of the stomach and the commencement of the intestine are marked by a thick ring of muscle fibres, the *sphincter pylori*, and in many cases by a distinct constriction due to the contraction of the sphincter. The first part of the intestine, the *duodenum*, runs backwards from the pylorus to the upper part or *neck* of

the gall-bladder; there it turns downwards and disappears from view behind a portion of the large intestine called the transverse colon. To trace it further, turn the greater omentum upwards over the lower part of the thoracic wall and expose the area below and behind the omentum. The central and greater portion of that area is filled with coils

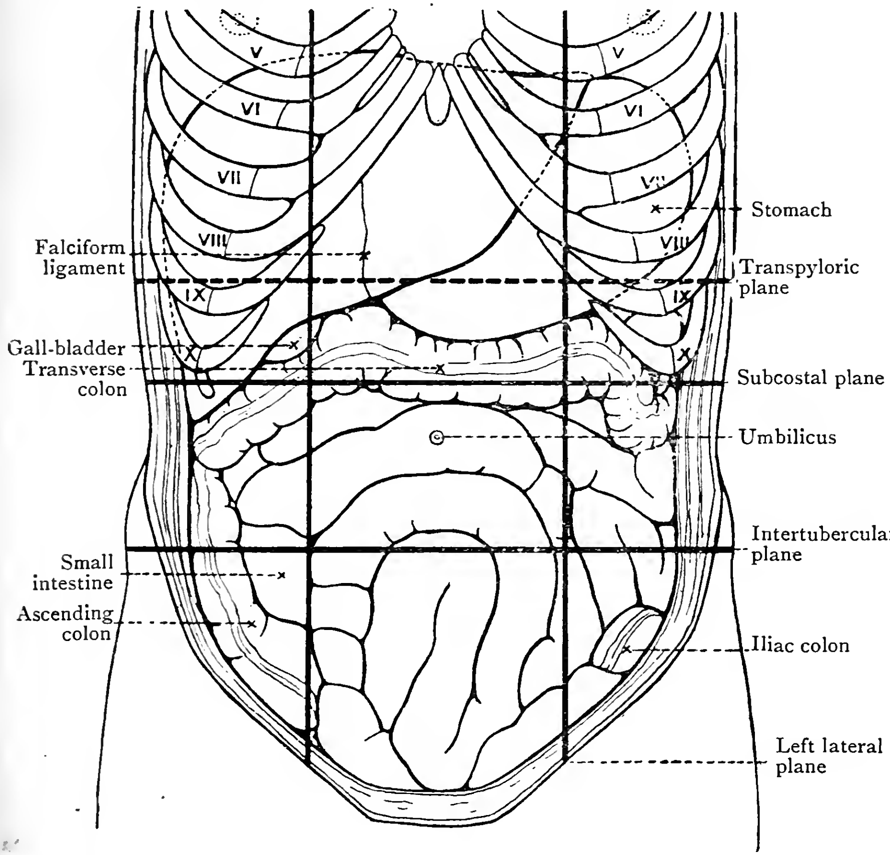

FIG. 128.—The Abdominal Viscera, as seen from the front, after removal of the greater omentum. The dark lines indicate the subdivision of the abdominal cavity. (Birmingham.)

of the small intestine, but at the lateral and upper borders of the area portions of the large intestine are seen.

A mere glance is sufficient to distinguish the small from the large intestine. The chief points of difference are—(1) The wall of the small intestine is smooth and uniform, whereas the wall of the large intestine is puckered and sacculated. (2) The longitudinal muscle fibres in the wall of

the small intestine are distributed uniformly round the tube, but in the large intestine they are collected into three longitudinal bands, called *tæniæ coli*, which are separated from each other by intervals and are distinctly visible to the naked eye. The bands are shorter than the tube itself; consequently the walls of the tube are puckered. (3) Attached to the great intestine are the *appendices epiploicæ*. They are small peritoneal pouches, containing fat, which hang from the free border of the gut.

The dissector should attempt to pull the small intestine forwards, and he will find that it is attached to the posterior wall of the abdomen by a fold of peritoneum, called *the mesentery*, which runs obliquely downwards and to the right, from the level of the left side of the second lumbar vertebra to the right iliac fossa.

The parts of the large intestine lying to the right of the mass of coils of small intestine are the cæcum below and the ascending colon above. The part crossing from side to side is the transverse colon; it is above the small intestine, now that the greater omentum is reversed, but it is normally in front of the small intestine; it is attached to the posterior wall of the abdomen by a fold of peritoneum called the *transverse meso-colon*. The parts to the left of the coils of the small intestine are, from above downwards, the descending colon in the lumbar region, and the iliac colon in the left iliac region.

The portion of the small intestine which is attached to the posterior wall of the abdomen by the mesentery is arbitrarily divided into two parts, an upper two-fifths, called *jejunum* (*intestinum jejunum*), and a lower three-fifths, called *ileum* (*intestinum ileum*). Pull the jejunum and ileum downwards and to the left and follow the mesentery to its highest point, there the jejunum will be found to become continuous with the terminal part of the duodenum at a distinct flexure, the *duodeno-jejunal flexure*, which is not enclosed in the mesentery but lies behind the peritoneum below the arch of the transverse meso-colon. If the dissector will now hold the omentum forwards he will be able to trace the first or superior part of the duodenum from the pyloric end of the stomach, backwards to the neck of the gall-bladder, the second or descending part downwards behind the transverse colon, on the right of the median plane,

and finally the third or inferior part from right to left, behind the upper part of the mesentery, to the duodeno-jejunal flexure, where it becomes continuous with the jejunum. He will thus demonstrate the continuity of the three portions of the duodenum.

Next he should follow the mesentery downwards into the right iliac fossa, where he will find that the terminal portion of the ileum joins the large intestine a short distance above the lower end of the latter and on its left side. The portion of the large intestine below the entrance of the ileum is a sac which terminates blindly below and is called the *cæcum* (*intestinum cæcum*). Turn the cæcum and the lowest part of the ileum upwards and to the right to expose the *vermiform process*, which springs from the medial and posterior aspect of the cæcum a short distance below the ileo-cæcal junction. The cæcum is continuous above with the *ascending colon*, which must be traced upwards to the right hypochondriac region where, under cover of the anterior part of the lower surface of the liver, it joins the transverse colon at an angular bend, called the *right flexure of the colon* (O.T. *hepatic flexure*). The *transverse colon* extends across the abdomen from the right to the left hypochondriac region, forming a bold curve with the convexity directed downwards and forwards. It is connected to the stomach by the greater omentum and to the posterior wall of the abdomen by the transverse meso-colon. It is exposed when the omentum is turned upwards over the lower part of the costal arch and it will be found to terminate, immediately below the inferior extremity of the spleen, by joining the *descending colon* at a second angular bend, called the *left flexure of the colon* (O.T. *splenic flexure*). The descending colon passes downwards through the left lumbar region, and, at the level of the iliac crest, it becomes the *iliac colon*, which runs downwards and medially across the left iliac region, parallel with the inguinal ligament, to the brim of the pelvis minor, where it becomes the *pelvic colon*. To expose the pelvic colon lift the coils of small intestine out of the pelvis minor. It will then be found either that the pelvic colon runs first across to the right side of the pelvis, above the bladder, then back to the left side, and finally downwards and medially to the third piece of the sacrum, where it becomes continuous with the *rectum*; or that the first loop, instead of lying on the upper

surface of the bladder, hangs down into the pelvis close to its left side. The *rectum* commences at the termination of the pelvic colon and runs downwards and forwards to end in the anal canal. Only its upper part can be seen at present, the lower part being concealed by the bladder, and in the female by the vagina (see Figs. 85, 224).

It is extremely important that the surgeon, who is operating in the abdomen, shall be able to tell at once whether he is handling a coil of small or of large intestine. The dissector should note that the size of the coil cannot be depended upon to decide the question, for the size depends to a large extent on the state of contraction or distension of the wall of the gut. Position is a better guide, but it also is not entirely reliable, for portions of the large intestine are very liable to be displaced from their usual positions. There are, however, certain external characteristics of the two main parts of the intestine which can always be relied upon to furnish the necessary evidence. (1) The walls of the large intestine are sacculated; (2) The longitudinal muscle fibres of the wall of the large intestine form three definite bands, two of which can usually be distinguished through the peritoneum, one along the free border of the gut, that is the border opposite the mesenteric attachment, or furthest away from the posterior wall of the abdomen, and another which lies along the medial border, in the cases of the ascending, descending, iliac, and pelvic portions of the colon, and along the inferior border of the transverse colon; (3) The third and, at the same time, the most easily recognisable and most distinctive feature of the large intestine is the presence of little fat-laden pouches of peritoneum called *appendices epiploicæ*, which are attached to the free border of the gut. None of the three features mentioned in connection with the large intestine are present in the case of the small intestine; on the contrary, its walls are not sacculated; it possesses no specialised longitudinal muscular bands, and it has no appendices epiploicæ attached to its walls.

If the subject is a female the **uterus** will be found occupying the central part of the pelvis. It lies between the rectum behind, and the bladder in front, and is connected on each side to the side wall of the pelvis by a fold of peritoneum called the *broad ligament* (see Figs. 224, 225, 228).

The dissector should notice that the cæcum presents the

appearance of a blind diverticulum clothed on all sides with peritoneum; that the transverse colon and the pelvic colon are attached to the posterior wall of the abdomen by folds of peritoneum called mesenteries; that the vermiform process is attached to the posterior surface of the mesentery of the ileum by a fold of peritoneum called the *mesentery of the vermiform process* (O.T. meso-appendix); and that the remaining parts of the large intestine are not, as a rule, provided with mesenteries, but that they lie against the posterior wall of the abdomen, projecting forwards against the peritoneum, which covers them only anteriorly and on the sides. He should also note that portions of both the large and the small intestine lie in the pelvis minor. The parts of the small intestine in that situation are usually the lower coils of the ileum, and the parts of the large intestine are the pelvic colon and the rectum.

After the dissector has familiarised himself with the positions, continuity, and attachments of the various parts of the abdominal portion of the alimentary canal he should proceed to locate the kidneys. Throw the omentum upwards, pull the small intestine downwards and to the right, and examine the concavity of the left flexure of the colon, where a considerable part of the lower portion of the left kidney can be *seen and felt*, as it lies behind the peritoneum. Pull the small intestine over to the left and downwards, examine the concavity of the right flexure of the colon, and note that only a small part of the lower portion of the right kidney can be felt and seen in that situation, behind the peritoneum. Replace the small intestine and the omentum, pull the liver upwards and to the right, and the greater part of the upper portion of the right kidney will be exposed or can be felt in the region immediately above the right flexure of the colon. Replace the liver and pass the hand backwards into the posterior part of the left hypochondrium, to the back of the spleen, and palpate the upper and lateral part of the left kidney, as it lies against the diaphragm.

The positions and connections of the various viscera must now be studied in greater detail. Commence with the consideration of the liver.

Hepar (The Liver).—The liver has already been seen in the subcostal angle and projecting below the right costal margin. It is the largest gland in the body, and is

a solid pliant organ, which occupies a large part of the epigastric and right hypochondriac regions, and smaller portions of the left hypochondriac and right lumbar regions. It is almost entirely surrounded by the peritoneal lining of the abdomen. The portions which can be investigated, at the present stage of dissection, are smooth to the touch, and they present a smooth and glistening appearance. The dissector should pass his hand over the surfaces of the organ

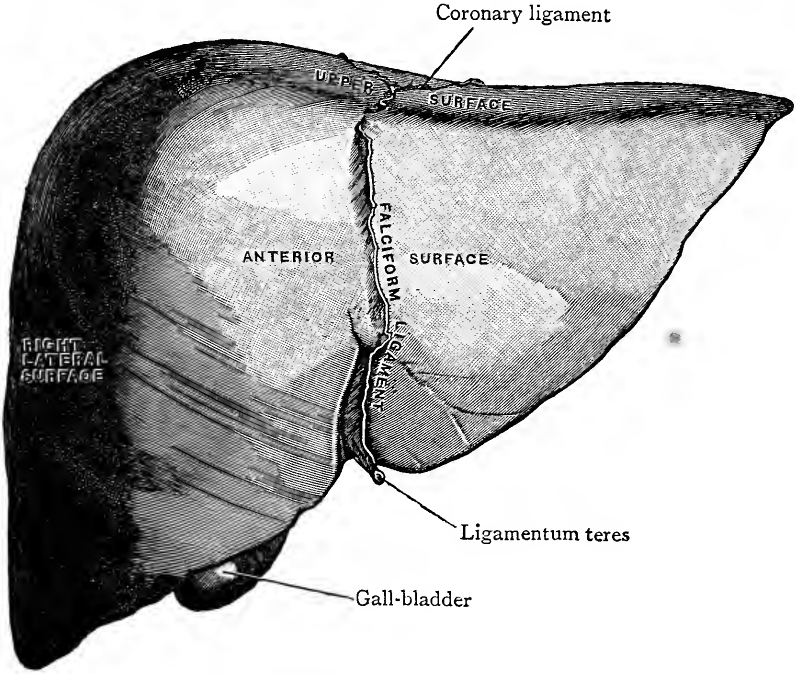

FIG. 129.—Anterior Surface of the Liver.

and he will find that it has the form of an irregular four-sided pyramid. The *base* of the pyramid lies to the right, where it is in contact with the diaphragm, from the level of the seventh to the level of the eleventh rib in the mid-axillary line. The edge-like *apex* lies to the left, at the level of the left sixth rib in or near the left lateral plane. The *anterior* and *superior* surfaces are smooth and convex. The anterior is attached to the anterior abdominal wall, and the superior to the under surface of the diaphragm, by a fold of peritoneum, called the falciform ligament, which separates each surface into a smaller left and a larger right portion, corresponding to the left and right lobes of the liver respectively.

The anterior surface is triangular in outline. It passes gradually, over rounded and indistinct borders, into the superior surface and the base, but it is separated from the inferior surface by a sharp and definite margin. Its left and right portions are in contact with the diaphragm, and the intermediate part is in contact with the anterior wall of the abdomen in the region of the subcostal angle. Its position can be indicated on the surface by three lines. (1) The first commences at the level of the left sixth rib in the left lateral plane, ascends to the fifth intercostal space in the right lateral plane, then descends in a steep curve to the seventh rib in the mid-axillary line. (2) The second commences at the same point as the first and passes obliquely downwards and to the right across the tip of the tenth right costal cartilage to the eleventh rib in the mid-axillary line. (3) The third connects the right extremities of the first and second.

The *superior surface* is accurately adapted to the lower surface of the diaphragm, which separates it from the lungs and pleuræ, and from the heart and pericardium. Immediately below the heart it is slightly concave, but to the right and left of the cardiac concavity it is markedly convex, and more convex on the right than on the left side. Pass the hand backwards over the upper surface of the right lobe and note that in the right lateral plane it rises to the level of the fourth intercostal space, or even to the lower border of the fourth rib.

Pass the hand still further back over the upper surface, and note that at the junction of the superior and posterior surfaces a layer of peritoneum, the upper layer of the *coronary ligament*, passes from the liver to the diaphragm. Carry the fingers to the right along the coronary ligament round to the base where, at the junction of the base with the posterior surface, a triangular fold of peritoneum, the *right triangular ligament*, will be found, connecting the liver with the diaphragm. Now pass the hand over the upper surface of the left lobe, and note that before the posterior border is reached the fingers are carried up to the diaphragm by a triangular fold of peritoneum, the *left triangular ligament* (see Fig. 172).

Examine the lower border of the anterior surface; note that it is cleft at the lower margin of the attachment of the falciform ligament by a notch called the *umbilical notch.* Through

that notch, between the right and left lobes, the ligamentum teres, which lies in the rounded lower margin of the falciform ligament, passes into the umbilical fossa on the lower surface of the liver. Further to the right, in or near the right lateral plane and opposite the tip of the ninth right costal cartilage, the fundus of the gall-bladder projects below the liver, in the majority of cases.

Raise the lower margin of the liver and examine the *inferior surface.* It looks downwards, backwards, and to the left, and, over the whole of its extent, it is in contact with other viscera; on that account it is frequently called the *visceral surface.* It conceals the upper and right portion of the anterior surface of the stomach, the first part and the upper portion of the second part of the duodenum, the lesser omentum, and the greater part of the gall-bladder; to the right of the gall-bladder it is in relation, posteriorly, with a large portion of the anterior surface of the right kidney, and, more anteriorly, with the right flexure of the colon (see Fig. 171). It is divided into right and left portions by a fossa, the *umbilical fossa*, which contains the ligamentum teres. The umbilical fossa extends from the umbilical notch in the lower border of the anterior surface to the junction of the inferior and posterior surfaces, where it becomes continuous with the *fossa for the ductus venosus.* Trace the lesser omentum upwards to the lower surface of the liver, and note that it is attached to the margins of a fissure, called the *porta hepatis*, which extends from the neck or uppermost part of the gall-bladder on the right to the umbilical fossa on the left. The *porta hepatis* lies immediately in front of the junction of the inferior with the posterior surface of the liver. Note, further, that the upper border of the lesser omentum is continued upwards on the posterior surface of the liver, where it is attached to the bottom of the fossa for the ductus venosus.

The posterior surface, which is largely in relation with the diaphragm, cannot be conveniently examined at present (see Fig. 172).

Vesica Fellea.—The gall-bladder is a small piriform sac, with a capacity of from 28.5 to 57 cc. (one to two ounces). Pull the liver upwards and to the right, and examine the position, attachments, and connections of the gall-bladder. It lies partly in the right hypochondriac region and partly in the epigastric region. Its lower extremity or fundus projects below

the lower margin of the anterior surface of the liver, at the level of the ninth right costal cartilage, in the right lateral plane, immediately to the right of the lateral border of the right rectus abdominis muscle. From that point the body of the organ runs upwards, backwards, and to the left, to the right extremity of the porta hepatis, where its constricted upper end, called the *neck*, becomes continuous with the *cystic duct*, which connects the gall-bladder with the bile duct. The upper and anterior surface of the body of the gall-bladder is embedded in a sulcus on the inferior surface of the right lobe of the liver, which is called the *fossa for the gall-bladder*; and it is attached to the liver by areolar tissue and by a number of small veins which pass from the gall-bladder into the substance of the liver, where they communicate with branches of the portal vein. The fundus and the lower or posterior surface are covered with peritoneum, and the lower surface is in contact, posteriorly and above, with the first and second parts of the duodenum, and below with the transverse colon.

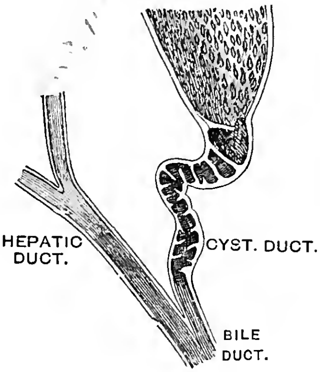

FIG. 130. — Diagram of the Cystic and Hepatic Ducts. (From Gegenbaur, modified.)

The cystic duct is enclosed in the right extremity of the upper border of the lesser omentum.

Dissection.—Make a longitudinal incision through the lower surface of the gall-bladder from the fundus to the neck, and examine the structure of its walls and its lining membrane. In addition to its partial serous covering it has (1) a strong coat composed of muscular and white fibrous tissue, and (2) an internal mucous coat. The mucous membrane is stained green by the bile, and it presents a honeycombed appearance, being raised into numerous ridges which surround polygonal depressions; in the neck of the gall-bladder the ridges assume a spiral form and constitute the so-called *spiral valve* of Heister, which is continued into the cystic duct.

To obtain a satisfactory view of the lesser omentum and its contents the left lobe of the liver must be removed. Cut through it from before backwards, immediately to the left of the line of attachment of the falciform ligament. On the lower surface the knife must be carried backwards along the umbilical fossa, close to its left margin, and it must emerge on the posterior surface in the fossa for the ductus venosus and close to the left margin of that fossa (see Fig. 131).

The portion of liver removed must be carefully preserved so that it may afterwards be re-attached to the right lobe.

Omentum Minus.—The lesser omentum is a fold of peritoneum which connects the lesser curvature of the stomach and the first part of the duodenum with the margins of the porta hepatis (O.T. transverse fissure) on the inferior surface of the liver, and with the bottom of the fossa for the ductus venosus on the posterior surface. Its left and lower margin is attached to the stomach and duodenum; its upper margin is attached to the liver; its right border is free and forms the anterior boundary of an aperture, called the *foramen epiploicum* (O.T. foramen of Winslow), which connects the cavity of the larger part of the peritoneal sac, called the *great sac*, with the smaller part, which is termed the *omental bursa*. The guide to the epiploic foramen is the gall-bladder. If the dissector passes his index finger upwards and backwards along the lower surface of the gall-bladder to its neck, and then turns it backwards and to the left, he will find that it passes through the epiploic foramen into the omental bursa.

The lesser omentum contains a large number of important structures between its two layers, viz.—two of the arteries which supply the stomach; the hepatic artery and the portal vein, which carry blood to the liver; the bile ducts, through which the bile is conducted to the duodenum; and numerous nerves, lymph vessels, and lymph glands. The dissector should now display the structures in the lesser omentum by removing portions of the anterior layer of the fold. It is not probable that he will be able to remove it in a continuous sheet; but he must take care not to destroy the posterior layer.

Dissection.—Commence at the upper border of the stomach, immediately below the œsophagus. Cut through the anterior layer of the lesser omentum and expose the *left gastric artery*; follow the artery downwards to its anastomosis with the *right gastric branch* of the hepatic artery, and upwards to the point at which it gives off its œsophageal branch; trace the latter along the œsophagus to the diaphragm. Remove the peritoneum from the front of the œsophagus and find the *left vagus nerve*, which descends on the front of the lower end of the œsophagus. Trace the terminal branches of the nerve to the wall of the stomach and into the lesser omentum. Whilst cleaning the left gastric artery the dissector may possibly see some of the *anterior left gastric lymph glands* at the upper extremity of the lesser curvature. Trace the right gastric

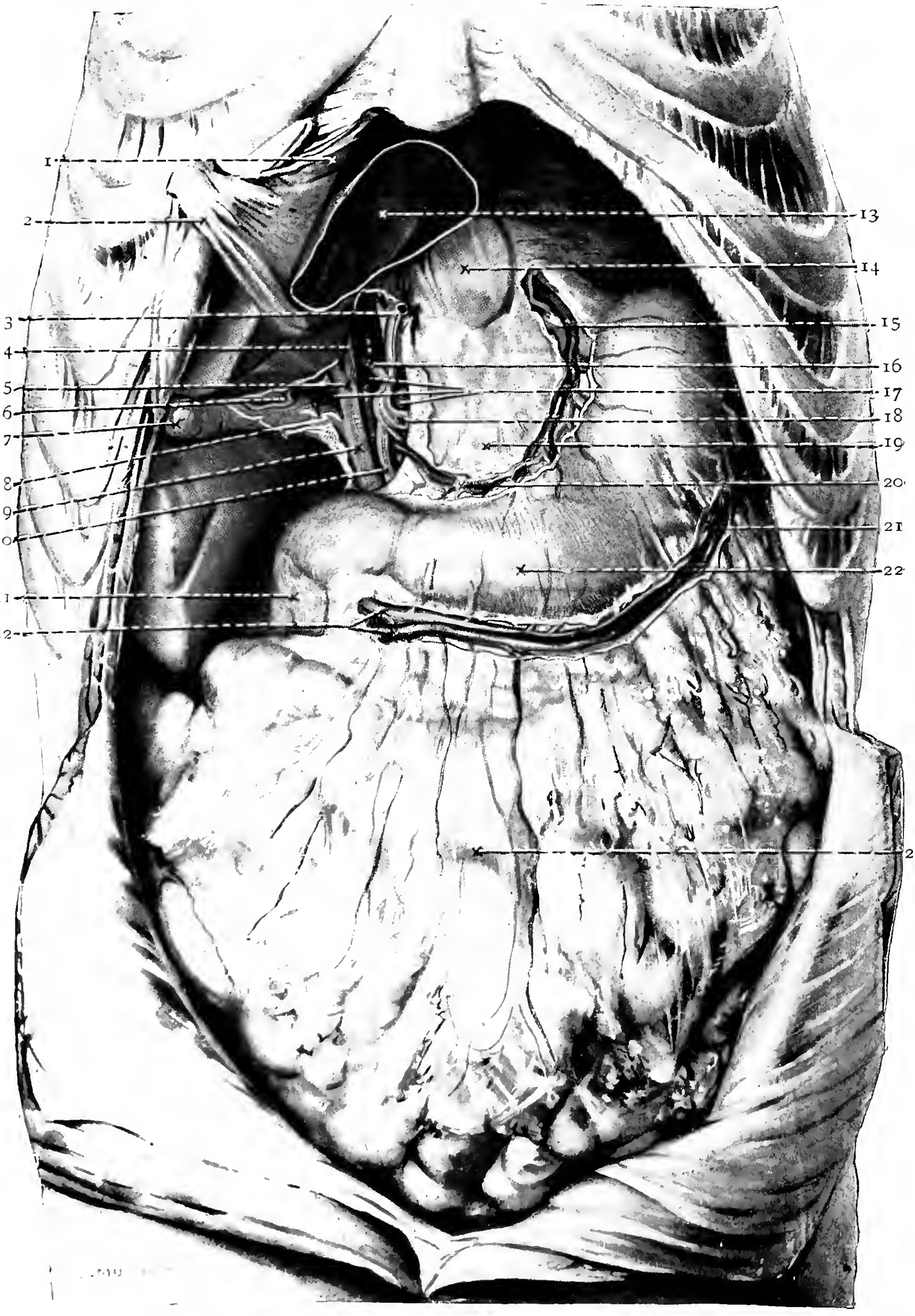

FIG. 131.

PLATE XII

FIG. 131.—View of the Interior of the Abdomen.

The upper part of the anterior wall of the abdomen has been removed. The lower part has been divided in the median plane and turned aside.

The greater part of the left lobe of the liver has been removed and the pyloric part of the stomach has been displaced downwards.

The liver is seen in the upper and right portion of the abdominal cavity, with the gall-bladder and the cystic artery on the inferior surface of its right lobe.

The round ligament of the liver and the falciform ligament have been pulled over the right costal arch and have been fixed to the wall of the thorax. From the point of attachment the round ligament runs downwards and backwards to the umbilical fossa of the liver, and the falciform ligament extends backwards to the anterior and upper surfaces of the liver.

Below and to the left of the liver is the stomach, which is connected to the liver by a fold of peritoneum called the lesser omentum. From the lower border of the stomach the greater omentum hangs down in front of the contents of the lower part of the abdominal cavity.

The anterior layer of the lesser omentum has been removed along the upper or lesser curvature of the stomach, to display the right and left gastric vessels, which lie between the two layers; and it has been removed also along the right or free margin of the omentum, to display the hepatic artery and its branches, the portal vein and the bile duct, the cystic duct and the common hepatic duct.

By the displacement downwards of the pyloric end of the stomach, the gastro-duodenal branch of the hepatic artery has been brought into view.

The anterior layer of the greater omentum has been removed along the lower part of the greater curvature of the stomach to display the right and the left gastro-epiploic vessels.

1. Falciform ligament.
2. Ligamentum teres.
3. Left hepatic artery.
4. Left hepatic duct.
5. Common hepatic duct.
6. Cystic artery.
7. Fundus of gall-bladder.
8. Cystic duct.
9. Bile duct.
10. Gastro-duodenal artery.
11. Duodenum, descending part.
12. Right gastro-epiploic vessels.
13. Face of section of left lobe of liver.
14. Caudate lobe, seen through lesser omentum.
15. Left gastric artery.
16. Right hepatic artery.
17. Portal vein.
18. Hepatic artery.
19. Lesser omentum.
20. Right gastric vessels.
21. Left gastro-epiploic artery.
22. Stomach.
23. Greater omentum.

artery to its origin from the *hepatic artery* and follow the latter upwards, in the right border of the lesser omentum, to its division into right and left branches immediately below the porta hepatis. On the walls of the artery some of the fibres of the hepatic plexus of sympathetic nerves may be recognised, and at its side some of the *biliary lymph glands* may be seen. Clean both terminal branches of the hepatic artery carefully, especially the right branch, which passes either anterior or posterior to the hepatic duct. To the right of the hepatic artery find the *bile duct*; trace it downwards to the point where it disappears behind the first part of the duodenum, and upwards to the upper border of the lesser omentum, where it is formed by the union of the *common hepatic duct* with the *cystic duct*. Follow the cystic duct to the neck of the gall-bladder, noting that it makes an S-shaped bend. Continue the incision already made in the gall-bladder into the cystic duct and note that the spiral arrangement of the mucous membrane is continued into the duct. Follow the common hepatic duct upwards into the porta hepatis, to the point where it is formed by the union of the *right* and *left hepatic ducts*, which come respectively from the right and left lobes of the liver. Clean away the areolar tissue from between the hepatic artery and the bile duct and display the *portal vein*, which lies behind them. Trace it upwards to its division into right and left branches at the porta hepatis, and downwards to the first part of the duodenum, where it disappears from view at the present stage of dissection. Note that the portal vein lies immediately in front of the epiploic foramen (Winslow), and that its posterior surface is covered by the peritoneum of the anterior margin of the foramen.

Omentum Majus (The Greater Omentum). — After the dissector has displayed and studied the structures situated between the two layers of the lesser omentum he should examine the greater omentum, which hangs down, like an apron, in front of the viscera which lie in the lower part of the abdomen. It is a double fold of peritoneum and consists, therefore, of two anterior and two posterior layers, the former being separated from the latter by a portion of the cavity of the omental bursa. The upper margins of the anterior two layers are attached to the lower part of the greater curvature of the stomach, where they become continuous with the peritoneum on the anterior and posterior surfaces of that viscus. To the left and above, the anterior two layers are continuous with the two layers of the gastro-splenic ligament, but at a lower level the anterior two layers become continuous with the posterior two layers at the free left border. Similarly at the lower and the right margins of the greater omentum the anterior two layers become continuous with the posterior two layers. The upper margins of the posterior two layers are attached to the lower border of the transverse colon, and, through the


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FIG. 132.

PLATE XIII

FIG. 132.—Dissection of the Abdomen to display the Posterior Wall of the Omental Bursa and some of its relations; a stage further of the dissection shown in Fig. 131.

The greater part of the left lobe of the liver has been removed and the remainder of the liver has been displaced upwards and to the right. The round ligament of the liver and the falciform ligament have been stitched to the right costal arch. All the lesser omentum, except the posterior layer of its right free margin, has been removed or turned aside.

The greater omentum has been detached from the lower part of the greater curvature of the stomach and a large segment of the wall formed by its anterior two layers has been removed.

The stomach has been divided near its pyloric end and afterwards turned upwards and to the left under cover of the left costal arch, to the margin of which the divided end has been fastened.

A portion of the peritoneal layer which forms the upper part of the posterior wall of the omental bursa has been removed to display a part of the pancreas.

The posterior wall of the omental bursa, which is displayed, is formed from below upwards by—(1) the posterior two layers of the greater omentum. (2) The transverse colon, enclosed between two layers of peritoneum which are continuous below with the posterior two layers of the greater omentum and above with the two layers of the transverse meso-colon. (3) The transverse meso-colon, formed by two layers of peritoneum of which only the upper or anterior is visible in the figure. (4) The ascending layer of the transverse meso-colon, which is the upward prolongation of the upper layer of the transverse meso-colon across the anterior surface of the pancreas to the diaphragm.

1. Cut surface of left lobe of liver.
2. Falciform ligament.
3. Ligamentum teres.
4. Left hepatic artery.
5. Right hepatic artery.
6. Common hepatic duct.
7. Cystic duct.
8. Fundus of gall-bladder.
9. Bile duct.
10. Duodenum, junction of superior and descending parts.
11. Transverse colon.
12. Cut edge of anterior wall of omental bursa.
13. Stomach.
14. Part of greater omentum.
15. Cut edge of lesser omentum.
16. Lesser omentum.
17. Caudate lobe of liver.
18. Stomach.
19. Left gastro-pancreatic fold.
20. Left gastric artery.
21. Right inferior phrenic artery.
22. Hepatic artery, in right gastro-pancreatic fold.
23. Pancreas.
24. Left gastro-epiploic artery.
25. Splenic artery.
26. Gastro-duodenal artery.
27. Superior pancreatico-duodenal artery.
28. Right gastro-epiploic artery.
29. Transverse meso-colon.
30. Posterior wall of omental bursa.
31. Anterior two layers of greater omentum.

peritoneum on the anterior and posterior surfaces of the latter, they become continuous with the two layers of the transverse meso-colon, which attaches the transverse colon to the structures lying on the posterior wall of the abdomen. The contents of the greater omentum are—(1) a portion of the cavity of the omental bursa which separates the anterior two layers from the posterior two layers; (2) between the anterior two layers, along the lower border of the stomach, the right and left gastro-epiploic blood vessels and their branches, with lymph vessels and small lymph glands; (3) between the posterior two layers lie small branches of the middle colic artery, which have crossed the surfaces of the transverse colon and are descending into the lower border of the greater omentum, where, in very favourable circumstances, their anastomoses with descending branches of the gastro-epiploic arteries may be seen.

Dissection.—Take away the more superficial of the anterior two layers of the greater omentum along the lower border of the stomach and expose the gastro-epiploic arteries. Trace the left artery to the left to the gastro-splenic ligament, and note that it passes forwards to the stomach between the two layers of that ligament. At a later stage it will be followed to the splenic artery, from which it springs. Trace the right artery to the right to the point where it springs from the gastro-duodenal artery at the lower border of the first part of the duodenum.

Remove the anterior two layers of the greater omentum (see Fig. 132). This part of the dissection is not always easy to accomplish, for not uncommonly the posterior of the anterior two layers is fused with the anterior of the posterior two layers, the lower part of the cavity of the omental bursa being obliterated; but if the dissector commences near the left end of the lower border of the stomach he will usually find the cavity persistent. First, he should pull the lower border of the stomach forwards, and cut through the anterior two layers of the omentum below the left gastro-epiploic artery; next, he should introduce his fingers through the opening and gradually separate the anterior two layers from the posterior two layers; then he must enlarge the opening, and, after separating the anterior from the posterior layers as far as possible, he must cut away the anterior layers. After that portion of the dissection is completed he must introduce one hand into the cavity of the omental bursa and he will find that he can pass it upwards behind the stomach and behind the posterior surface of the lesser omentum to the liver. If now he turns his fingers to the right he will be able to pass them behind the portal vein and through the epiploic foramen into the great sac. He should note, as he passes his hand upwards, that the cavity of the omental bursa is constricted, between the œsophagus above and to the left, and the pylorus below and to the right, by two folds of peritoneum which pass forwards from the posterior wall of the abdomen

to the œsophagus and the pylorus respectively. He will find, at a later stage of the dissection, that the two folds are connected with the peritoneum on the anterior surface of the pancreas; they are therefore called the left and right *gastro-pancreatic folds*. The left is produced by the left gastric artery as it passes round the left border of the sac to gain entrance into the lesser omentum, and the right is produced by the hepatic artery as it turns round the right margin of the sac at the lower border of the epiploic foramen (Winslowi).

Next, remove the remainder of the lesser omentum and so open into the upper part of the omental bursa; but take care not to injure the contents of the lesser omentum. First cut through the posterior layer along the left border of the hepatic artery; then carry the incision upwards along the margin of the fossa for the ductus venosus. Finally cut through the posterior layer for a short distance along the lesser curvature of the stomach, along the left gastric artery, and turn the separated portion of the lesser omentum to the left over the stomach. Again introduce the hand from the lower part into the upper part of the omental bursa and examine again the constriction of the cavity between the œsophageal and pyloric ends of the stomach, and the gastro-pancreatic folds, which cause it.

It is not possible to make a thorough examination of the cavity of the omental bursa till the stomach, which lies in its anterior wall, has been turned aside. Divide the right gastric artery and the right gastro-epiploic artery immediately to the left of the pylorus, then cut through the stomach in the same situation and turn it over to the left side. The greater part of the anterior wall of the omental bursa is now removed, and the cavity and the remaining boundaries can be examined.

The Cavity of the Omental Bursa extends from the lower margin of the greater omentum below to the liver above, and a narrow, pouch-like recess is prolonged upwards, behind the liver, to the inferior surface of the diaphragm. The posterior wall of the sac is formed, from below upwards, by—(1) the posterior two layers of the greater omentum; (2) the transverse colon, covered with peritoneum; (3) the transverse meso-colon; and, above the line of attachment of the transverse meso-colon to the posterior abdominal wall, by (4) the upper of the two layers of the transverse meso-colon, the so-called "*ascending layer*," which passes upwards, in front of the pancreas, the upper and medial part of the left kidney, the left suprarenal gland and the crura of the diaphragm, to the under surface of the diaphragm, from which it is reflected forwards to the upper part of the posterior surface of the caudate lobe of the liver. The outline of the pancreas can be seen through the thin peritoneum; and the kidney and the suprarenal glands, if not visible, are easily felt.

The narrow, pouch-like upper portion of the cavity of the

omental bursa is bounded posteriorly, as already stated, by the peritoneum on the abdominal surface of the crura of the diaphragm; superiorly, by the reflection of the peritoneum forwards to the posterior surface of the liver; anteriorly, by the peritoneum on the posterior surface of a small subdivision of the posterior aspect of the right lobe of the liver called the caudate lobe (O.T. Spigelian); on the left, by the reflection of the posterior layer of the lesser omentum from the margin of the fossa for the ductus venosus to the crura of the diaphragm; and, on the right, by the reflection of the peritoneum from the right crus of the diaphragm to the right lateral margin of the caudate lobe. When the body is recumbent, the recess is the most dependent part of the omental bursa.

The anterior wall of the omental bursa is formed, from above downwards, by the peritoneum on the posterior surface of the caudate lobe of the liver, the lesser omentum, the peritoneum on the posterior surface of the stomach, and by the anterior two layers of the greater omentum.

The left lateral boundary is formed—(1) in the region of the uppermost recess, by the reflection of the peritoneum from the fossa for the ductus venosus to the crura of the diaphragm; at a lower level, posteriorly, by (2) the lieno-renal ligament, which passes from the left kidney to the spleen (see Fig. 136); and anteriorly by (3) the gastro-splenic ligament, which connects the spleen with the stomach; and, at a still lower level, by (4) the union of the anterior two layers with the posterior two layers of the greater omentum at the left free border of the omentum (Fig. 137). The splenic artery runs forwards in the left lateral wall, between the layers of the lieno-renal ligament; and the short gastric branches and the left gastro-epiploic branch of the splenic artery run onwards to the stomach between the layers of the gastro-splenic ligament.

The right lateral wall is formed, from below upwards, by the union of the anterior two layers with the posterior two layers of the greater omentum at its right free border (Fig. 137); next, by the reflection of the posterior of the anterior two layers backwards from the posterior surface of the first part of the duodenum to the front of the pancreas, where it becomes continuous with the ascending layer of the transverse mesocolon (Fig. 136). Immediately above the duodenum the right boundary is absent and the omental bursa communicates

with the great sac through the epiploic foramen. Above the epiploic foramen the right margin of the omental bursa is formed, in the upper recess, by the reflection of the peritoneum from the right border of the caudate lobe of the liver to the right crus of the diaphragm. The hepatic artery turns round

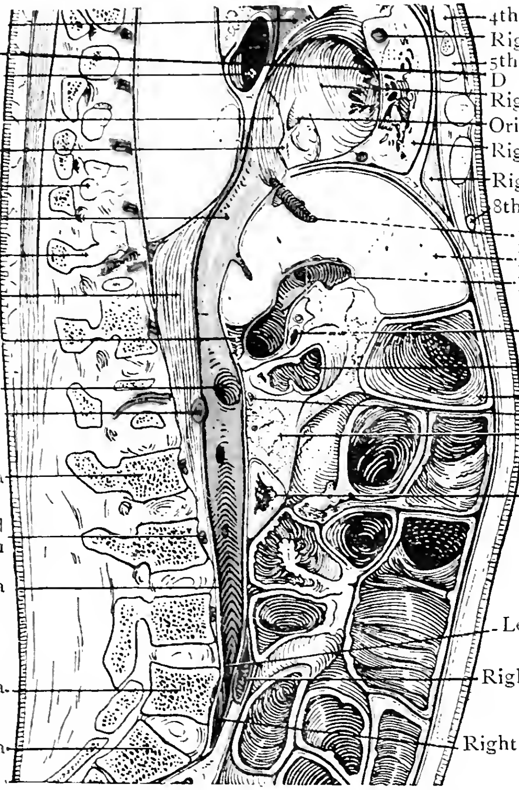

FIG. 133.—Sagittal section of the upper part of the Abdomen and the lower part of the Thorax of a Young Male Adult along the line of the Inferior Vena Cava.

D-D; Plane of Section shown in Fig. 21.

Note that in this subject the lower part of the heart was behind the 7th costal cartilage.

the right border of the bursa immediately behind the upper border of the first part of the duodenum, producing the right gastro-pancreatic fold previously mentioned.

The Great Sac of the Peritoneum.—After the dissector has made himself thoroughly conversant with the cavity of the omental bursa he should study the cavity of the great sac. It is the cavity into which he opened when he cut through

the abdominal walls to display the interior of the abdomen. It extends from the diaphragm above to the pelvic floor below (Fig. 134), across the abdomen from one side wall to the other (Fig. 135); and it is divided by the lower part of the

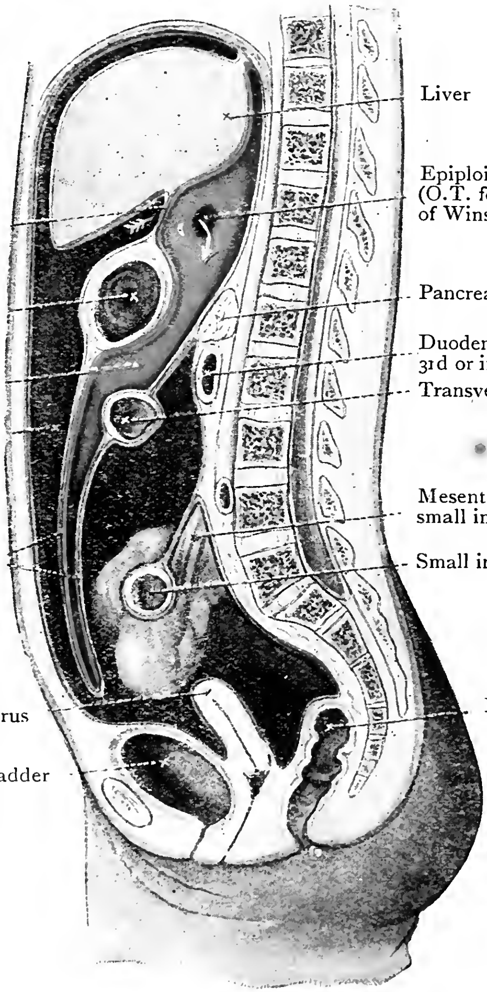

FIG. 134.—Sagittal section of Abdomen showing cavities.

walls of the omental bursa—that is, by the greater omentum, the transverse colon and the transverse meso-colon—into an upper and anterior, and a lower and posterior part, which are continuous with each other round the borders of the greater omentum (see Fig. 137). The upper and anterior part of the sac extends upwards to the lower surface of the diaphragm,

where it intervenes between the liver and the diaphragm, and where it is separated into right and left parts by the falciform ligament. The right part of the upper portion extends backwards, between the liver and the diaphragm, to the coronary ligament, which separates the upper surface of the right lobe of the liver from the posterior surface (Fig. 172): the left part of the upper end of the sac passes back-

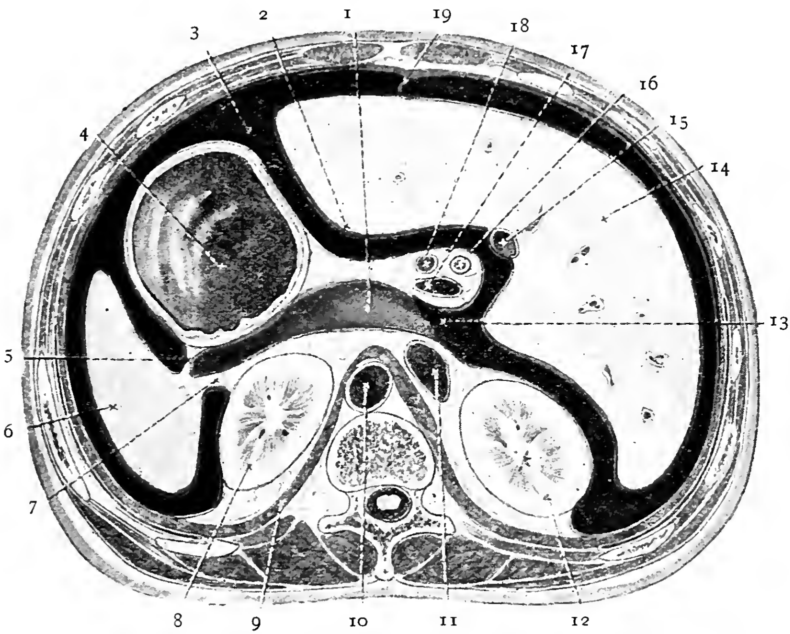

FIG. 135.—Transverse section of Abdomen at the level of the Epiploic Foramen.

1. Omental bursa (O.T. small sac).
2. Omental tubercle of liver.
3. Great sac.
4. Stomach.
5. Gastro-splenic ligament (O.T. gastro-splenic omentum).
6. Spleen.
7. Lieno-renal ligament.
8. Left kidney.
9. Diaphragm.
10. Aorta.
11. Inferior vena cava.
12. Right kidney.
13. Epiploic foramen (O.T. foramen of [Winslow).
14. Liver.
15. Gall-bladder.
16. Bile duct.
17. Portal vein.
18. Hepatic artery.
19. Falciform ligament.

wards, over the upper surface of the left lobe of the liver, to the left triangular ligament. Below the free margin of the falciform ligament the upper and anterior part of the great sac extends, as a continuous cavity, from side to side, and it projects backwards, on each side, deeply into the hypochondriac, lumbar, and iliac regions (see Figs. 136 and 137). The backward extensions of the great sac form two deep gutters, one on each side, in which collections of

fluid may become lodged when the body is lying recumbent. The lateral boundary of each of the gutter-like recesses is the side wall of the abdomen, formed superiorly by the diaphragm, which separates the peritoneal gutter from the lower part of the pleural sac, and inferiorly by the flat muscles of the abdomen. The medial wall of the right gutter is formed by the right kidney and the ascending colon (see Figs. 136

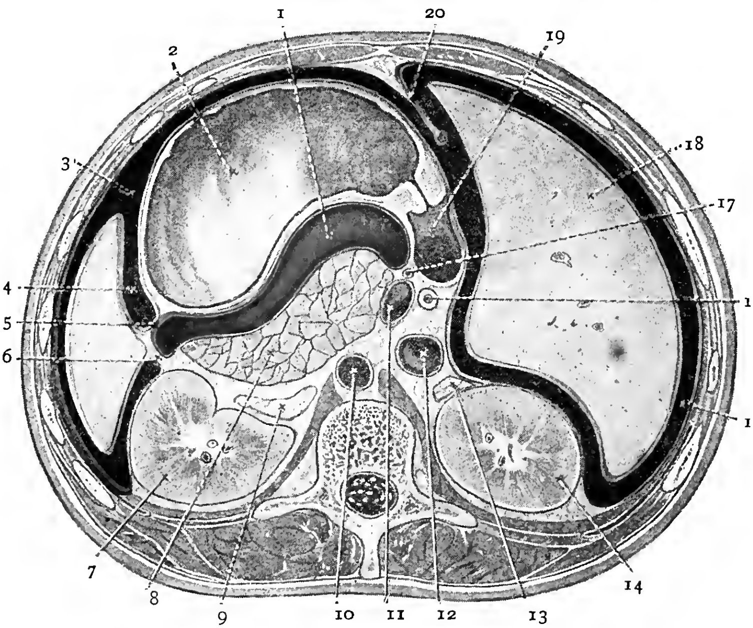

FIG. 136.—Transverse section of Abdomen immediately below the Epiploic Foramen.

1. Omental bursa (O.T. small sac).
2. Stomach. 3. Great sac. 4. Great sac.
5. Gastro-splenic ligament (O.T. gastro-splenic omentum).
6. Lieno-renal ligament.
7. Left kidney.
8. Pancreas.
9. Left suprarenal gland.
10. Aorta. 11. Portal vein.
12. Inferior vena cava.
13. Right suprarenal gland.
14. Right kidney.
15. Great sac.
16. Bile duct.
17. Gastro-duodenal artery.
18. Liver.
19. Duodenum, 1st part.
20. Falciform ligament.

and 137); and the medial wall of the left gutter by the lieno-renal ligament and left kidney above and by the descending colon below (see Figs. 136 and 137).

The dissector should pass his hand, from above downwards, along each lateral gutter of the great sac, and he will find that it is divided by a transverse fold of the peritoneal wall into an upper and a lower part, but the division occurs at very different levels on the opposite sides. The fold which

separates the upper from the lower part of the left gutter is the phrenico-colic ligament, which lies at the level of the eleventh rib in the mid-axillary line. On the right side the dividing fold is placed much lower and is frequently less distinct. It passes from the side wall of the abdomen, in the upper part of the iliac region, to the lateral wall of the lower part of the ascending colon. The lateral gutters and the folds

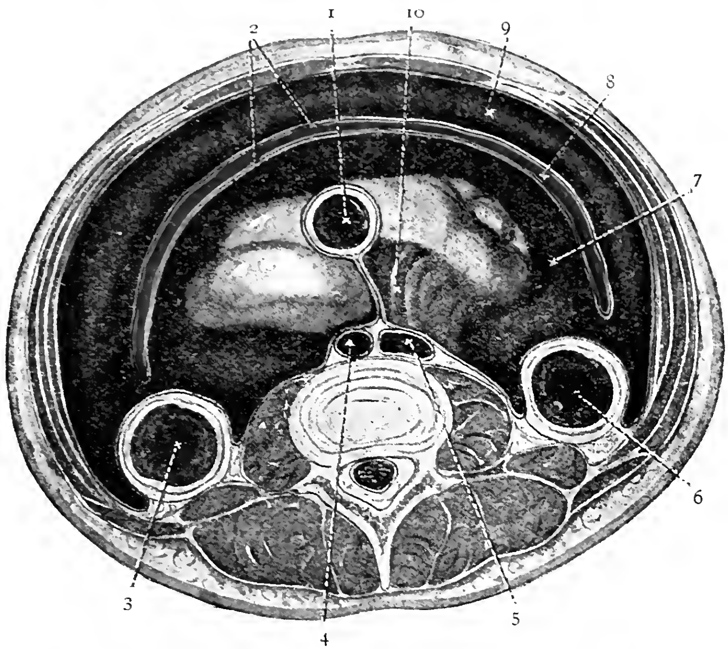

FIG. 137.—Transverse section of Abdomen through the fourth lumbar vertebræ.

1. Small intestine.
2. Greater omentum and omental bursa.
3. Descending colon.
4. Aorta.
5. Inferior vena cava.
6. Ascending colon.
7. Great sac.
8. Omental bursa (O.T. small sac).
9. Great sac.
10. Mesentery.

which divide them are of importance because they tend to localise abnormal collections of blood or inflammatory effusions which may be in the cavity of the great sac; and the dissector should note that in the recumbent posture the lowest part of each lateral gutter is situated at the level of the upper part of the kidney, in the region of the last intercostal space.

The upper portion of the posterior part of the cavity of the great sac—the part behind the greater omentum—also is divided, in the upper part of its extent, into two parts, by the

mesentery of the small intestine, which runs obliquely from the left side of the second lumbar vertebra to the right iliac fossa. The upper boundary of each subdivision of the posterior and lower part of the cavity of the great sac is the transverse meso-colon (Fig. 134). The lateral boundary of the right part

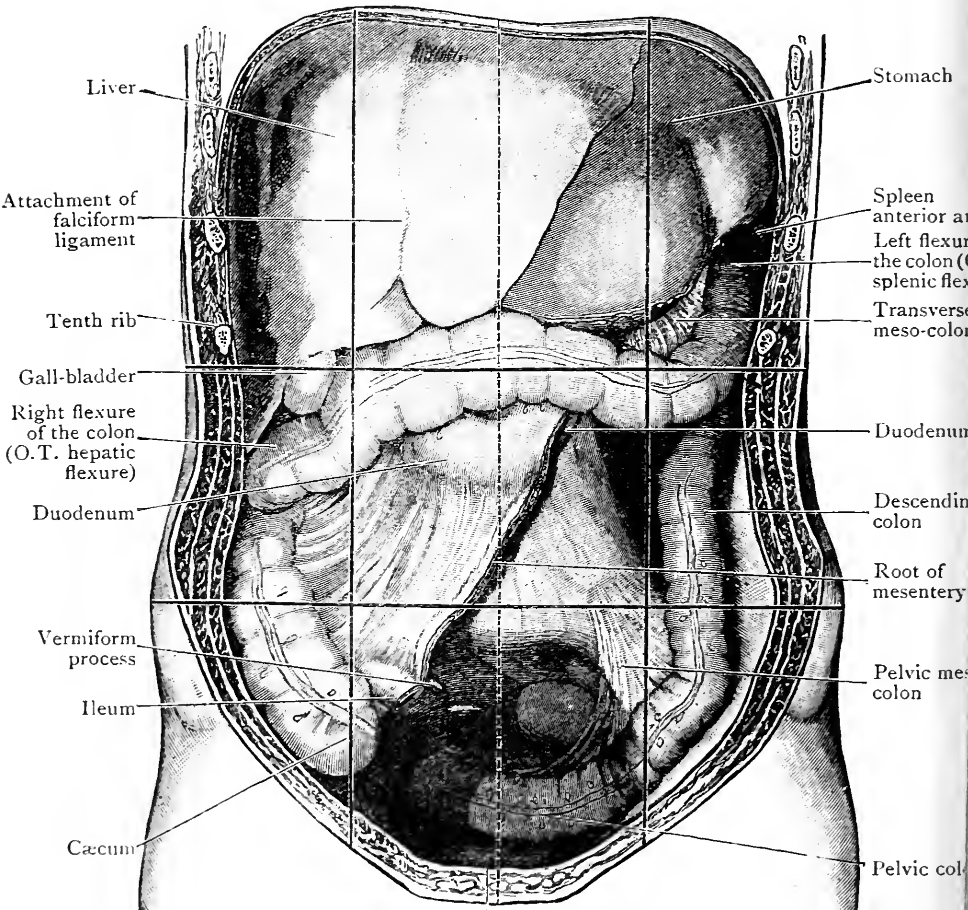

FIG. 138.—Abdominal viscera after removal of jejunum and ileum. (Birmingham.)

is the ascending colon, and of the left part the descending colon (Fig. 137). The lateral gutter of the right part of the posterior portion of the great sac terminates below at the union of the ileum with the large intestine (see Fig. 138); and the lateral gutter on the left side is continued downwards into the pelvis between the mesentery of the small intestine and the mesentery of the pelvic colon.

The lower portion of the posterior part of the cavity of the great sac lies upon the floor of the pelvis, and, in the male, it forms three definite pouches: a median, and a right and left lateral pouch. The median or recto-vesical pouch is bounded in front by the bladder, behind by the rectum, and laterally, on each side, by a sacro-genital fold of peritoneum, which passes from the region of the fundus of the bladder, past the side of the rectum, to the sacrum. Each of the two lateral pouches is bounded medially by the side of the bladder and the sacro-genital fold, and laterally by the side wall of the pelvis. In the female, by the interposition of the uterus and the upper part of the vagina, between the bladder and the rectum, two median pouches are formed —a larger posterior pouch, the *recto-uterine pouch* (*pouch of Douglas*), and a smaller anterior pouch, the *utero-vesical pouch*; and the broad ligament, which connects the lateral border of the uterus with the side wall of the pelvis, divides each of the single lateral pouches present in the male into an anterior or *paravesical pouch*, and a posterior part, the *lateral pouch of Douglas*, in which the ovary and the termination of the oviduct are situated.

Peritoneum.—The peritoneum is the great serous membrane which forms the wall of the peritoneal cavity. Externally it is blended with the subserous or extra-peritoneal tissue of the abdomen, in which the vessels and visceral nerves of the abdomen lie. Internally it is covered with a flat, glistening epithelium. In the male, the cavity of the peritoneal sac is closed; that is, it does not communicate with the exterior of the body. In the female, on the other hand, it does communicate with the exterior through the female genital passages, viz. the uterine tubes, the uterus, and the vagina.

When the abdomen was opened the cavity of the peritoneum also was opened, and the dissector's attention was drawn to the smooth and glistening appearance of the inner surface of the serous membrane which is due to the lining epithelium. As the examination of the cavity proceeded the dissector must have noted that the peritoneum gave more or less complete coverings to the various abdominal viscera, and that its posterior wall was raised into numerous complicated folds. The folds are the result of the invagination of the wall of the sac by the adjacent viscera, and the

complication of the folds has been produced by changes in form and position of the viscera, and by the fusion and partial disappearance of some of the primitive folds.

The portion of the peritoneum which lines the inner surface of the abdominal wall is called *parietal peritoneum.* The portion which covers the viscera is termed *visceral peritoneum*; and the folds which connect the viscera with each other or with the wall of the abdomen are defined as omenta, mesenteries, and ligaments.

The term *mesentery* is *generally* applied to folds of peritoneum which connect portions of the intestine with the posterior wall of the abdomen.

The term *omentum* has usually been applied, in English terminology, to folds of peritoneum which connect the stomach with other viscera. The term *ligament* was limited to any fold which did not fall into either of the two first divisions; now, however, it is becoming customary to extend the term to folds and portions of folds which connect the stomach to adjacent viscera; thus the lesser omentum is said to consist of the *hepato-gastric* and the *hepato-duodenal ligaments*, the two terms being applied respectively to the parts which connect the liver to the stomach and the liver to the duodenum. The gastro-splenic omentum becomes the *gastro-splenic ligament*, and the greater omentum is sometimes spoken of as the *gastro-colic ligament.*

The relations of the layers of the visceral and parietal peritoneum to each other, and the relations of the layers which bound the omental bursa to those which limit the cavity of the great sac, can be easily followed in Figs. 134, 135, 136, and 137. The dissector should study the figures and confirm their accuracy by following the peritoneum in his "part" at the levels, and in the planes, indicated in them.

Dissection.—After examining the various parts of the peritoneal cavity, and the different folds of the peritoneal membrane, the dissector should remove the peritoneum of the posterior wall of the omental bursa, above the level of the root of the transverse meso-colon. Commence immediately above the line of attachment of the transverse meso-colon to the lower border of the pancreas, which can be seen through the thin peritoneum, and work upwards, taking care not to injure either the pancreas itself or the blood-vessels which lie behind the posterior wall of the upper part of the omental bursa. Remove also the medial layer of the gastro-splenic ligament, and the medial layer of the lieno-renal ligament. The object of this dissection

PLATE XIV

FIG. 139.—Further Stage of the Dissection of the Abdomen.

The œsophagus and the gastro-phrenic ligament have been divided close to the diaphragm.

The gastro-splenic ligament has been divided close to the hilum of the spleen.

The transverse meso-colon has been divided close to its attachment to the duodenum and the pancreas.

The transverse colon has been divided close to the right and left colic flexures; and the stomach and the transverse colon, with the greater omentum and its contained part of the omental bursa, have been removed.

The jejunum has been divided close to the duodeno-jejunal flexure, and the ileum close to the cæcum, and the intervening part of the small intestine and its mesentery have been removed. The peritoneum has been taken away from the upper part of the posterior wall of the pelvis minor, and from the area on the posterior wall of the abdomen which is bounded by the cæcum and the ascending colon on the right, and the descending and iliac portions of the colon on the left.

The peritoneum of the posterior wall of the upper part of the omental bursa has also been removed.

By the removal of the posterior wall of the upper part of the omental bursa, the body and tail of the pancreas, the crura of the diaphragm, the left inferior phrenic artery and a portion of the splenic artery have been displayed.

By the removal of the transverse colon and the greater part of the small intestine, the transverse and ascending portions of the inferior part of the duodenum have been brought into view; and, by the removal of the peritoneum from the posterior wall of the lower part of the abdomen, the ureters, and the vessels, nerves, and muscles lying immediately behind the peritoneum in that region, have been exposed.

1. Cut surface of left lobe of liver.
2. Falciform ligament.
3. Ligamentum teres.
4. Caudate lobe.
5. Left hepatic artery.
6. Right hepatic artery.
7. Hepatic duct.
8. Portal vein.
9. Fundus of gall-bladder.
10. Cystic duct.
11. Bile duct.
12. Duodenum, superior part.
13. Gastro-duodenal artery.
14. Sup. pancreatico-duodenal artery.
15. Right gastro-epiploic artery.
16. Right kidney.
17. Inferior vena cava.
18. Right flexure of the colon.
19. Psoas major muscle.
20. Spermatic vessels crossing ureter.
21. Common trunk of ileo-colic and right colic arteries.
22. Genito-femoral nerve.
23. Right common iliac artery.
24. Middle sacral vessels.
25. Cæcum.
26. Ileum.
27. Vermiform process.
28. Pelvic colon.
29. Cut edge of lesser omentum.
30. Œsophagus.
31. Left crus of diaphragm.
32. Right crus of diaphragm.
33. Left inferior phrenic artery.
34. Left gastric artery.
35. Right inferior phrenic artery.
36. Spleen.
37. Pancreas.
38. Left gastro-epiploic artery.
39. Splenic artery.
40. Left flexure of the colon.
41. Duodeno-jejunal flexure.
42. Middle colic artery.
43. Left kidney.
44. Inferior mesenteric vein.
45. Left colic artery.
46. Psoas major muscle.
47. Inferior mesenteric artery.
48. Spermatic vessels.
49. Ureter.
50. Sigmoid arteries.
51. Genito-femoral nerve.
52. Superior hæmorrhoidal artery.
53. Iliac colon.

is to display—(1) the anterior surface of the body, the neck, and part of the head of the pancreas; (2) a part of the anterior surface of the left kidney; (3) the anterior surface of the left suprarenal gland; (4) the left cœliac ganglion and the left greater splanchnic nerve; (5) the upper part of the abdominal portion of the aorta; (6) the cœliac artery and its branches, viz. the hepatic, the splenic, and the left gastric artery—and their branches; (7) the inferior phrenic arteries; (8) the upper parts of the crura of the diaphragm; (9) the terminal part of the right vagus nerve.

Clean the pancreas first, and do not disturb it from its position. At the upper border of the pancreas, in the median plane, and below the caudate lobe of the liver, find the cœliac artery, dividing into its three terminal branches: the hepatic, running to the right; the splenic, to the left along the upper border, or immediately behind the upper border, of the pancreas; and the left gastric, running upwards and to the left to the junction of the œsophagus with the stomach. Trace the first portion of the hepatic artery, through the right gastro-pancreatic fold, to the right free margin of the omentum, where it has already been exposed, and, if possible, preserve the sympathetic nerve filaments which surround it. Secure its *gastro-duodenal branch*, which descends behind the first part of the duodenum and in front of the neck of the pancreas, and trace it to its division into the superior *pancreatico-duodenal* and the *right gastro-epiploic arteries*. Trace the latter to the left to the point where the stomach was divided. Trace the *splenic artery* to the left, to the anterior surface of the left kidney, and then forwards, along the left layer of the lieno-renal ligament, which is still *in situ*, to the spleen, and note that before it reaches the spleen it gives off a number of *short gastric branches*, and the *left gastro-epiploic artery*, which run forwards to the stomach, along the left layer of the gastro-splenic ligament, which also is still in position. Note, further, that the splenic artery breaks up into branches before it reaches the spleen. In many cases the short gastric branches and the left gastro-epiploic artery spring from the terminal branches, and not from the trunk of the splenic artery. Secure also the branches from the splenic artery to the pancreas, and, if possible, preserve the sympathetic nerve plexus which surrounds the artery. Follow the *left gastric artery*, through the left gastro-pancreatic fold, to the junction of the œsophagus with the stomach, where the artery gives off its œsophageal branch or branches; secure also the accompanying vein, *the coronary vein of the stomach*, and trace it, across the median plane, to its union with the portal vein at the lower end of the right free margin of the lesser omentum. Trace the *cœliac artery* backwards to its origin from the front of the aorta, and do not injure the plexus of sympathetic nerve filaments which surrounds it.

Immediately to the left of the cœliac artery, and at the upper border of the pancreas, find the *left cœliac ganglion*, which is connected with the plexus of nerves round the root of the cœliac artery. Follow the ganglion upwards and backwards to its union with the left greater splanchnic nerve. Immediately to the left of the ganglion find the *left suprarenal gland*, and, below it, the upper and medial part of the anterior surface of the *left kidney*.

Find the inferior phrenic arteries, one on each side, immedi-

ately above the level of the cœliac artery; trace each medially to its origin from the aorta, and laterally across the surface of the corresponding crus of the diaphragm; note that the left passes behind the œsophagus; the right passes behind the inferior vena cava, but the two facts cannot be demonstrated until a later period.

Clean the posterior surface of the abdominal part of the œsophagus and secure the *right vagus nerve* which runs downwards upon it; trace the branches of the vagus along the wall of the stomach and towards the spleen. Finally, clean the crura of the diaphragm to the level of the orifice through which the œsophagus enters the abdomen.

When the dissection is completed the dissector is in a position to study the cœliac artery and its branches, the blood supply of the stomach, and the bed of the stomach.

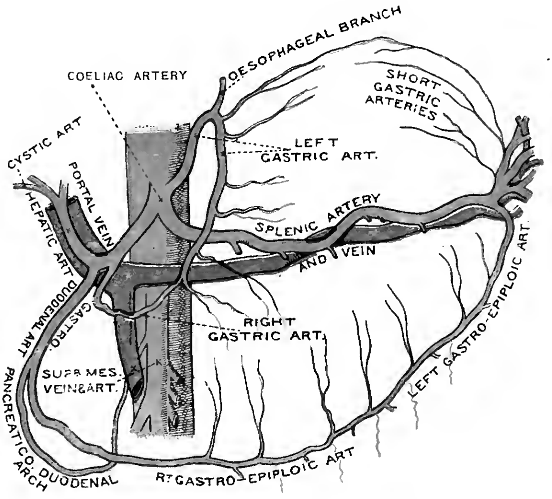

FIG. 140.—The Cœliac Artery and its branches.

Arteria Cœliaca (O.T. **Cœliac Axis**).—The cœliac artery is a short, wide vessel, which springs from the front of the aorta, between the two crura of the diaphragm, immediately above the upper margin of the pancreas. It is directed horizontally forwards, and, after a course of little more than 12·5 mm. (half an inch), divides into three branches, viz.—(1) the left gastric; (2) the hepatic; and (3) the splenic—which radiate from each other like the spokes of a wheel. The hepatic and splenic branches are large, but the left gastric branch is relatively small.

The cœliac artery is surrounded by a thick, matted plexus of nerves, called the *cœliac plexus*, which sends numerous nerve twigs with the three branches of the artery.

Arteria Gastrica Sinistra (O.T. Coronary Artery).—The left gastric artery is the smallest of the three branches of the cœliac artery; it proceeds upwards and to the left, behind the omental bursa and through the left gastro-pancreatic fold, to the œsophageal opening of the stomach, where it changes its direction, enters between the two layers of the lesser omentum, and runs, from above downwards and to the right, along the lesser curvature of the stomach. Near the pylorus it ends by anastomosing with the *right gastric branch* of the hepatic artery.

The branches of the left gastric artery are:—

1. Œsophageal.
2. Gastric.

Rami Œsophagei.—Two or three œsophageal branches may arise separately, or by a common trunk, from the left gastric artery at the point where it reaches the stomach. They pass upwards, through the œsophageal opening of the diaphragm, upon the posterior aspect of the gullet, and anastomose with the œsophageal branches of the thoracic aorta.

The *gastric branches* take origin from the trunk, as it runs along the lesser curvature of the stomach, and are distributed to both surfaces of this viscus.

Vena Coronaria Ventriculi.—The coronary vein of the stomach accompanies the left gastric artery, along the lesser curvature of the stomach and behind the omental bursa, to the cœliac artery; then, continuing to the right, it crosses in front of the aorta and joins the portal vein at the lower border of the epiploic foramen.

Arteria Hepatica.—The hepatic artery is intermediate in size between the left gastric and the splenic. At first it runs transversely to the right, along the upper border of the pancreas. At the pylorus it changes its direction, and turns forwards, below the epiploic foramen, in the right gastro-pancreatic fold; then it ascends between the two layers of the lesser omentum. Near the porta hepatis it ends by dividing into *right* and *left hepatic arteries.* The hepatic artery is accompanied by numerous large nerve twigs derived from the cœliac plexus, and, as it passes upwards to the liver, it is in close relationship with the bile duct and the portal vein. The duct lies upon the right side of the

artery, and the vein lies behind both. (Fig. 135, p. 291, and Fig. 139, p. 297.)

The following are the branches of the hepatic artery:—

1. A. gastrica dextra.
2. A. gastro-duodenalis. { A. pancreatico-duodenalis superior. / A. gastro-epiploica dextra.
3. A. hepatica propria. { Ramus dextra. { A. Cystica. / Ramus sinistra.

The *right gastric artery* (O.T. *pyloric*) is a small artery which springs from the hepatic artery at the pylorus, and then runs from right to left, along the lesser curvature of the stomach, between the two layers of the lesser omentum. It ends by inosculating with the left gastric; the accompanying vein terminates in the portal vein.

The *gastro-duodenal artery* arises close to the right gastric artery. It descends, behind the first part of the duodenum, in a groove on the anterior aspect of the neck of the pancreas. At the lower border of the duodenum it ends by dividing into the superior pancreatico-duodenal and right gastro-epiploic branches (Fig. 140).

The *superior pancreatico-duodenal artery* runs first to the right, and then downwards between the head of the pancreas and the duodenum. It anastomoses with the *inferior pancreatico-duodenal branch* of the superior mesenteric artery, forming an arch round the head of the pancreas. It gives branches to both the duodenum and the pancreas. The pancreatico-duodenal veins join the superior mesenteric vein.

The *right gastro-epiploic artery* is directed from right to left, along the greater curvature of the stomach, between the anterior two layers of the greater omentum. It gives branches upwards to both surfaces of the stomach, and downwards to the greater omentum; and it ends by anastomosing with the *left gastro-epiploic* branch of the splenic artery. The right gastro-epiploic vein joins the superior mesenteric vein.

The *right* and *left hepatic arteries*, the terminal branches of the hepatic, diverge from each other, and sink into the liver at the two extremities of the porta hepatis. From the right hepatic a small branch, called the *cystic*, is given to the gall-bladder. The cystic artery divides into two twigs; one of the two ramifies in the areolar tissue between the over and gall-bladder, and the other upon the inferior surface

of the gall-bladder, between the gall-bladder and its peritoneal covering.

The *cystic vein* joins the vena portæ or its right branch.

Arteria Lienalis. — The splenic artery is the largest branch of the cœliac artery. It takes a wavy or tortuous course towards the left side, along the upper border of the pancreas, behind the omental bursa; and it ends, in front of the left kidney, by dividing into five or six branches, which enter the hilum of the spleen.

It is accompanied by the splenic vein, which, however, lies at a lower level, and therefore altogether behind the pancreas.

The following are the branches of the splenic artery:—

1. Arteriæ pancreaticæ.
2. Aa. gastricæ. { Aa. gastricæ breves. / A. gastro-epiploica sinistra. }
3. Rami lienales.

The *pancreatic arteries* are small twigs which come off at various points for the supply of the pancreas.

The *pancreatica magna branch*, which is sometimes described as accompanying the duct from left to right in the substance of the pancreas, is more commonly absent than present.

The *short gastric arteries* (O.T. *Vasa Brevia*) are five or six small arteries, of which some arise directly from the splenic, whilst others take origin from its terminal branches. They run towards the stomach, between the two layers of the gastro-splenic ligament, and are distributed to the cardiac part of the viscus (see p. 299), anastomosing with the left gastric and left gastro-epiploic arteries.

The *left gastro-epiploic artery* takes origin from the splenic, near the spleen, or from one of its terminal branches. It runs forwards, in the gastro-splenic ligament, and then turns to the right, along the greater curvature of the stomach, between the anterior two layers of the greater omentum, and it ends by anastomosing with the right gastro-epiploic artery. Some of its branches ascend, others descend. The ascending branches supply both surfaces of the stomach, and they anastomose with branches of the right and left gastric arteries and with the short gastric arteries. The descending branches pass downwards, between the two anterior layers of the greater omentum, and they may anastomose with branches of the middle colic artery.

The *splenic* or *terminal branches* of the splenic artery pass from the lieno-renal ligament into the hilum of the spleen.

From the above description of the branches of the cœliac artery it will be seen that the stomach is remarkably rich in blood-vessels. *Two* proceed from *left to right*—viz. the *left gastric*, along the lesser curvature, and the *left gastro-epiploic*, along the greater curvature; *two*, both branches of the hepatic, are directed from *right to left*—viz. the *right gastric*, in relation to the lesser curvature; and the *right gastro-epiploic*, in relation to the greater curvature. The arterial circle is completed on the left by the *short gastric arteries*, which connect the left gastric artery with the left gastro-epiploic.

The splenic vein, the portal vein, the bile duct, and the inferior phrenic arteries will be considered at a later stage of the dissection.

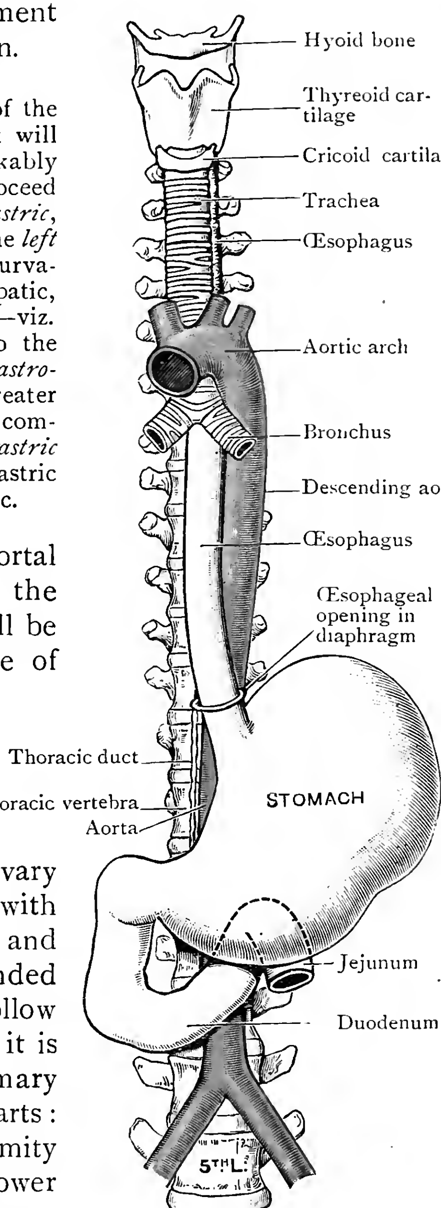

FIG. 141.—The Œsophagus, Stomach, and Duodenum.

Ventriculus.—The stomach is the most dilated section of the alimentary canal. Its size, shape and position vary considerably in association with the amount of its contents, and with the empty or distended condition of the adjacent hollow viscera, but, on the whole, it is pear-shaped, and it is customary to recognise the following parts: (1) a blunt left upper extremity or fundus; (2) a narrow lower and right extremity or pylorus; (3) an intermediate part separated into cardiac and pyloric portions; (4) two orifices, an œsophageal and a pyloric; (5) two surfaces, a superior and an inferior; (6) two borders or curvatures, a greater and a lesser.

It receives food through the œsophagus or gullet, which opens into the stomach at the upper end of the lesser curvature, below and to the right of the fundus, whilst at its lower, and right or pyloric extremity, it becomes continuous with the duodenum, which is the first part of the small intestine.

The *fundus* is full and rounded, and forms a marked bulging directed upwards and backwards. It occupies the back part of the left cupola of the diaphragm, from which it is partially separated by the spleen and the liver.

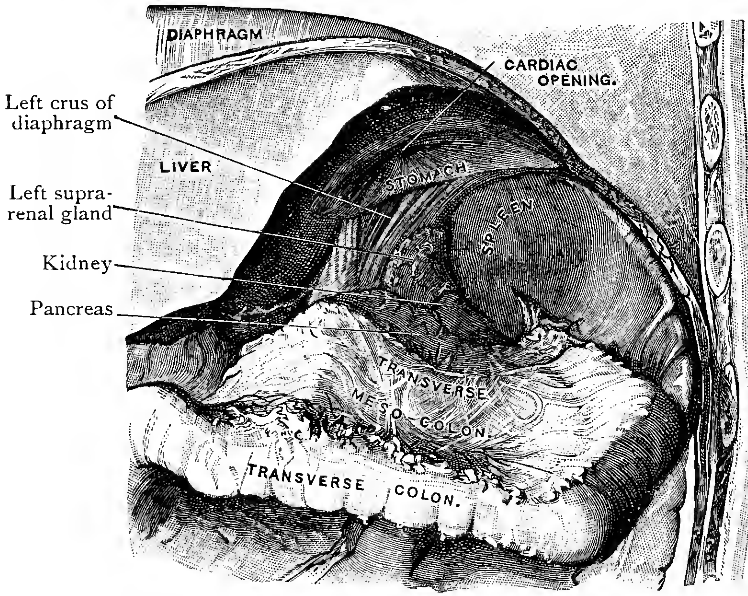

FIG. 142.—The Stomach has been removed from its bed so as to display the recess in which it lies.

The *œsophageal or cardiac orifice* is situated to the right of the fundus and about 50 mm. (two inches) below its summit. It lies at the upper end of the lesser curvature, but in certain conditions appears to be partly on the upper surface.

The *pylorus*, or narrow right extremity of the stomach, is, as a rule, directed backwards. It is continuous with the duodenum or commencement of the small intestine, the line of junction being marked, on the surface, by a slight but obvious constriction, termed the *duodeno-pyloric constriction.*

The two surfaces of the stomach, as a general rule, look for the most part upwards and downwards. The *upper surface* is fuller and more convex than the lower surface. It is

directed forwards, as well as upwards, and is covered, to a large extent, by the left lobe of the liver. Below and to the left of the sharp margin of the liver, however, a considerable portion of the superior surface of the stomach is in apposition partly with the diaphragm, and partly with the posterior aspect of the anterior abdominal wall.

The *inferior surface* of the stomach is flatter than the superior surface, and is supported by a slightly curved and sloping shelf, which projects forwards from the posterior wall of the abdomen. This has been appropriately called, by

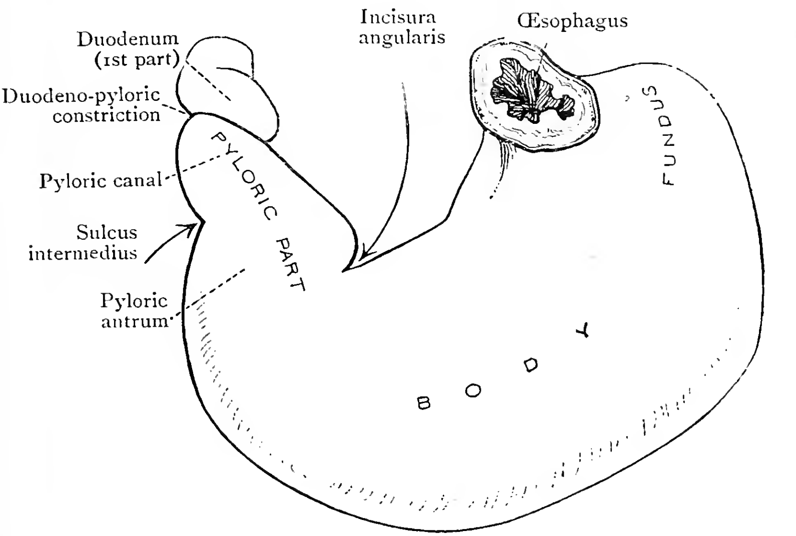

FIG. 143.—Outline of the upper aspect of the Stomach of a Child which has been hardened *in situ* by formalin injection. It is the outline of the upper surface of the stomach figured on p. 269.

Birmingham, the *stomach-bed.* It is formed by the following structures, all of which are related to the lower surface of the organ: (1) the diaphragm; (2) the gastric surface of the spleen; (3) the left suprarenal gland and a varying amount of the upper part of the left kidney; (4) the anterior surface of the pancreas; (5) the transverse meso-colon; and (6) the transverse colon. A niche of the great sac of the peritoneum intervenes between the stomach and the spleen (Fig. 135), and the omental bursa separates it from the left suprarenal gland, the kidney (Fig. 136), the pancreas, and colon, whilst the transverse meso-colon intervenes between it and the coils of the small intestine.

The right, upper, or posterior border of the stomach is termed its *lesser curvature.* It extends from the cardiac orifice to the pylorus, and curves round the base of an eminence on the lower surface of the left lobe of the liver, called the tuber omentale, and also, to a smaller extent, round a corresponding prominence of the pancreas. It is therefore concave, and it is connected to the liver and, to a slight extent, to the diaphragm by the lesser omentum. The left, lower, or anterior border of the stomach, called the *greater curvature* on account of its great length, is convex and is directed to the left and forwards; to its uppermost segment is attached the gastro-phrenic ligament; to its left lateral segment, the gastro-splenic ligament; and to its lowest or anterior segment, the greater omentum.

The stomach is not only curved along its long axis but it is also bent upon itself, more or less acutely. As a result of the bend a notch or angular depression is formed on the lesser curvature; it is called the *incisura angularis.* The presence of the incisura angularis is taken advantage of to divide the organ, for descriptive purposes, into two main parts, the *cardiac part* and the *pyloric part.* The cardiac part lies to the left of an imaginary plane which descends through the long axis of the stomach from the incisura angularis. Occasionally a distinct constriction occurs between the two parts, and the stomach is then said to be bilocular. The cardiac part is subdivided into an upper portion the *fundus*, and a lower portion the *body.* The plane of separation between the two lies at the level of the lower margin of the œsophageal orifice. The pyloric part is also subdivided into the *pyloric antrum* and the *pyloric canal.* The separation between the two segments of the pyloric portion is indicated on the surface of the stomach by a notch on the greater curvature called the *sulcus intermedius.* As a rule the pyloric canal is directed backwards, it is distinctly tubular, and it possesses relatively thick muscular walls, whilst the pyloric antrum is more dilated and its walls are relatively thin. The characteristic features of the two segments of the pyloric portion are not always evident. Occasionally, during digestion, all four segments of the stomach are evident as in the stomach shown in Fig. 122, where the gas-filled fundus, the vertical cylindrical body, and the somewhat bulbous pyloric antrum and the pyloric canal are obvious. In other cases, however, the lines

of separation between the body and the pyloric portion, and between the two segments of the pyloric portion, are less evident or are altogether absent (see Figs. 122, 124, 125, 126).

In certain phases of digestion the lower part of the body and the whole of the pyloric portion form together a tubular canal, along which waves of contraction pass to and fro, churning the contents into a unform consistence, whilst the remainder of the body and the fundus form a kind of passive

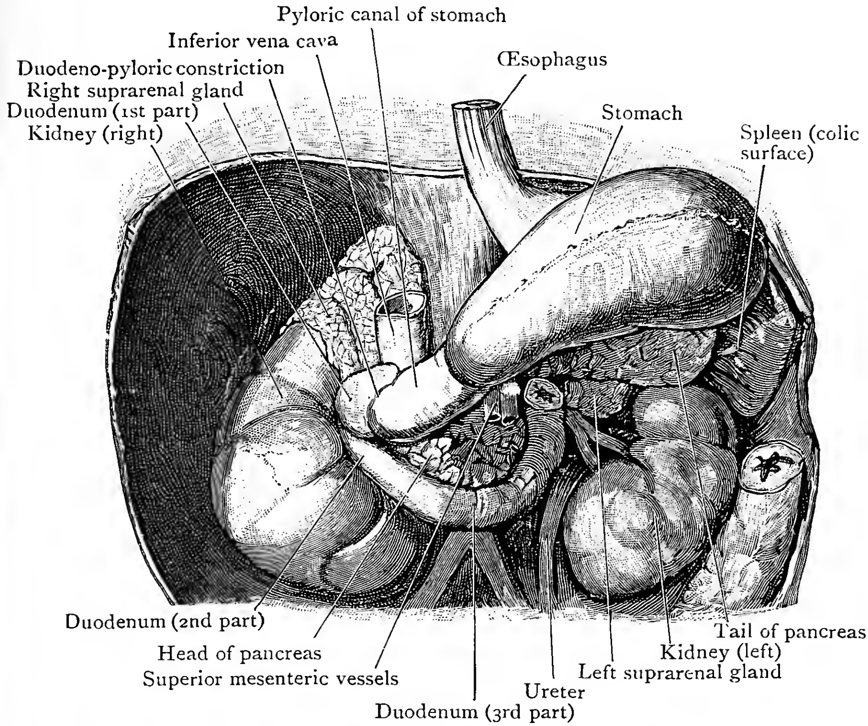

FIG. 144.—Horizontal position of the Stomach in a Child two years old; viscera hardened by formalin injection.

reservoir, from which food is squeezed into the more actively contracting segment, as the thoroughly churned material intermittently escapes through the pyloric orifice into the duodenum.

Position of the Stomach.—When *empty* and *contracted* the stomach lies more or less horizontally within the abdominal cavity; it is placed within the left hypochondrium and the left portion of the epigastrium. The organ is bent on itself like a sickle and the fundus looks directly backwards; the surfaces are directed upwards and downwards and the curva-

tures forwards and backwards—the greater curvature being at a slightly higher level than the lesser curvature; lastly, there is a gradual but decided downward slope of the upper surface from the fundus to the pylorus.

The pyloric extremity of the empty stomach lies in the transpyloric plane (Addison), either where the latter cuts the median plane, or from half an inch to an inch to the right of the median plane. The transpyloric plane is situated midway between the upper margin of the manubrium sterni and the upper margin of the symphysis pubis.

The conditions which give rise to the position and form of the empty stomach as described above are sufficiently obvious when the nature of the chamber within the abdomen which is occupied by the organ is considered. The roof of this chamber, formed by the liver and diaphragm, is more resistant, more unyielding, than the floor, which is formed chiefly by the transverse meso-colon, buoyed up by the movable coils of small intestine. As the stomach becomes empty and contracted, the intestine, acted on by the abdominal wall, rises up and presses it against the sloping visceral surface of the liver, and the slope or gradual descent to the right, which is so characteristic a feature of the upper surface of the empty stomach, is the result.

When the stomach becomes *full*, it may either retain the horizontal position, which is characteristic of the organ when it is empty, or it may assume a more or less oblique position. In both cases, it acquires more space within the abdomen by displacing neighbouring viscera, and the *pylorus* moves to the right, but not as a rule more than 35 to 50 mm. (an inch and a half to two inches) from the median plane. The pylorus does not alter its position in a vertical direction; it maintains the same level within the abdomen. The position of the *œsophageal opening* is only slightly affected by the emptying or the distension of the stomach. It is placed opposite the body of the tenth thoracic vertebra, and on the surface of the body its situation may be indicated by placing the finger on the seventh costal cartilage of the left side about one inch from the median plane.

As the stomach fills it becomes more rounded in general outline, and, should it assume the oblique position when full, the fundus is directed upwards, whilst the surfaces look forwards and backwards; further, the part of the greater curvature opposite the incisura angularis takes a median position and occupies a lower level than any other part of the stomach. It follows from this that the pyloric part

of the organ courses upwards and to the right to reach its termination.

While the various conditions which determine the position and form of the full stomach are under consideration, it is necessary to take into account the state of the movable, and as a rule yielding, floor of the stomach chamber. It is possible that the easiest and most natural way for the stomach to expand, under ordinary circumstances, is in a downward direction by intestinal displacement, and when this occurs the oblique portion of the organ is the result. But when the intestines are distended the stomach cannot acquire the necessary space in this manner, and the liver, which forms so large a part of the roof of the stomach chamber, has to give way before it. The obvious result of such a change in the position and form of the pliant liver is that the full stomach retains the horizontal position.

The dissector must remember that the description given above refers to the appearance presented by the stomach fixed and hardened after death when the body is lying on its back. It probably has a very similar form and similar relations during life when the body is recumbent; but when the body is erect the œsophageal orifice and the fundus retain their close relationships to the diaphragm and the pylorus remains at the level of the transpyloric plane, but the lowest part of the greater curvature descends to, or below, the level of the umbilicus, and the upper two-thirds of the organ becomes more tubular and lies more in a vertical plane (Figs. 122, 125).

When the stomach is empty it is questionable if it ever assumes, during life, the flaccid, relaxed, and flattened form which is so frequently seen in the dissecting-room, in subjects which have not been specially hardened. In life, the healthy stomach, by contraction of its muscular coat, adapts itself to its contents whether they are liquid, gaseous, or solid, and when empty and contracted its walls are thick and firm.

The Abdominal Part of the Œsophagus.—The abdominal part of the gullet is very short—probably never more than one inch in length. It lies in the upper and posterior part of the epigastric region, behind a groove in the posterior aspect of the left lobe of the liver, and in front of the left crus of the diaphragm. Its right border passes uniformly and gradually into the lesser curvature of the stomach, without the formation of an angle, but a very definite angle is formed between its left border and the fundus.

Relations between Thoracic and Abdominal Organs.—At this stage it is advisable to consider the relations between the abdominal and thoracic organs which lie upon the different aspects of the diaphragm. It has been noted that the right

lobe of the liver occupies the right vault of the diaphragm, whilst the left lobe of the liver, the fundus of the stomach, and the spleen occupy the left vault. The base of the right lung is in relation to the right lobe of the liver. The pericardium, in by far the greater part of its extent, lies above the left lobe of the liver, which therefore intervenes between it and the stomach; only a limited portion of the apex of the heart, which is inside the pericardium, extends over the region of the stomach. The base of the left lung lies over the left lobe of the liver, the fundus of the stomach, and the spleen.

Intestinum Tenue.—The small intestine is that part of the alimentary canal which succeeds the stomach. It begins, in the epigastric region, at the pylorus, and ends, in the upper part of the right iliac region, by joining the large intestine. Its average length is somewhere about seven metres (twenty-three feet). It diminishes slightly in calibre from its commencement to its termination, and it is divided into three portions, viz.:—

1. The duodenum.
2. The jejunum.
3. The ileum.

The *duodenum* is the name which is given to the first part of the small intestine. It is about 25 cm. (ten inches) long, and it extends, in a horse-shoe-shaped curve, from the pylorus to the left side of the body of the second lumbar vertebra. As it lies deeply in the greater part of its extent, and as further dissection is necessary to display its relations, it is not convenient to consider it at present.

The *jejunum* and *ileum* constitute the coils of the small intestine, which, under ordinary circumstances, are more or less completely covered in front by the greater omentum. The jejunum begins where the duodenum ends, viz. at the left side of the body of the second lumbar vertebra; and the ileum ends in the upper part of the right iliac region by joining the large intestine at the upper end of the cæcum. The subdivision of the small intestine is of the most arbitrary kind. It is customary for anatomists to look upon the upper two-fifths of the small intestine beyond the duodenum as being jejunum, and the lower three-fifths as being ileum. There is no hard-and-fast line of demarcation between those two divisions—the one passes insensibly into the other;

and, as the chief distinction is to be found by an examination of the interior of the tube, the student will not in the meantime see much difference between them.

To expose the commencement of the jejunum, the greater omentum, with the enclosed transverse colon, should be thrown upwards over the lower margin of the thoracic wall. The

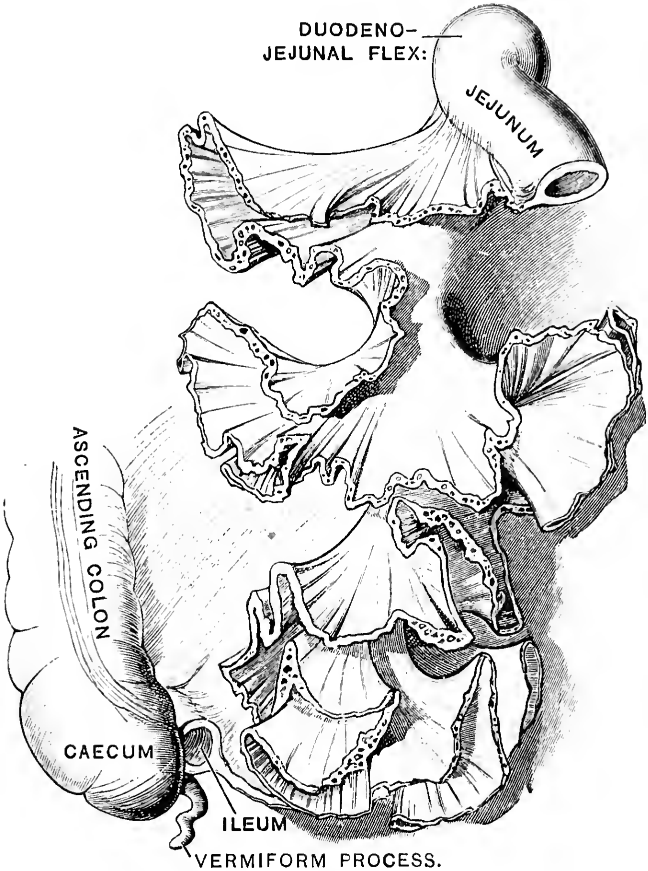

FIG. 145.—The Mesentery in a subject which was hardened by formalin injection. The jejunum and ileum have been removed, and the foldings of the mesentery are displayed.

coils of the small intestine should then be drawn over to the right. The junction between the duodenum and the jejunum will now be seen on the left side of the vertebral column, at the level of the second lumbar vertebra. The termination of the duodenum is fixed, partly by its relation to the peritoneum and partly by the suspensory muscle of the duodenum, which will be described later (p. 344); the commencement of the

jejunum bends suddenly forwards and downwards from it, forming the *duodeno-jejunal flexure.*

The lower coils of the ileum usually lie in the pelvis minor, and the terminal part of the ileum has, as a rule, no great latitude of movement. It ascends from the pelvis minor, across the right external iliac vessels and the corresponding psoas major muscle, to join the cæcum at the level of the intersection of the intertubercular and right lateral planes. To bring it into view lift the lower coils of the ileum from the pelvis minor and pull them towards the left side.

The coils formed by the jejunum and ileum are suspended from the posterior wall of the abdomen by a wide fold of peritoneum, called *the mesentery.* They are thus, for the main part, freely movable within the cavity. Owing to the manner in which the mesentery is attached to the posterior wall of the abdomen (Fig. 138, p. 294), they tend to lie more in the left than in the right portion of the cavity, and they occupy the umbilical, hypogastric, lumbar, and iliac regions, filling up the greater part of the abdominal cavity below the transverse colon and its mesentery. Some of the coils extend downwards into the pelvis minor, and not uncommonly one or more coils of the jejunum may be found in the left hypochondrium.

Meckel's Diverticulum.—In about 2 per cent. of subjects dissected a blind, hollow protrusion, termed Meckel's diverticulum, juts out at a right angle from the wall of the ileum, at a point rather less than three feet from the junction of the small intestine with the cæcum. It represents a persistent portion of the vitelline duct of the embryo, and under certain circumstances it may lead to conditions which require surgical interference.

The Mesentery of the Small Intestine.—The mesentery of the small intestine is an extensive fold of peritoneum by which the jejunum and ileum are attached to and suspended from the posterior wall of the abdomen. Its posterior border or *root* is attached along an oblique line which extends, from above downwards and to the right, from the left side of the second lumbar vertebra to the right iliac fossa, crossing in its course the third part of the duodenum, the abdominal aorta, the inferior vena cava, the right ureter, and the right psoas major muscle. This border is about six inches long. The anterior border of the mesentery is attached to the intestine, and is necessarily as long as the part of the gut to which it is attached,

that is, about twenty-two feet; but this great length is not at first apparent because the mesentery is thrown into folds like a frill (Fig. 145) and the coiled condition of the gut is due to that arrangement. Thus, the mesentery is markedly fan-like, and its length, from its root to its intestinal attachment, at its longest part, is about 15 cm. (six inches) after death and when the body is hardened, but it may be considerably longer during life.

The two layers of the peritoneum of the mesentery are not in apposition. They are separated by a variable amount of fat and areolar tissue in which lie the superior mesenteric artery and its branches to the jejunum and ileum, the corresponding veins, the accompanying nerves, the lymph vessels, called *lacteals*, passing from the gut, and numerous lymph glands. The jejunum and ileum lie in the free anterior border of the fold.

The amount of fat between the two layers of the mesentery varies, not only in different subjects but also in different parts of the mesentery. The amount is greatest near the root of the mesentery and smallest near the gut. The difference referred to is most marked in the upper part of the mesentery, near the duodena-jejunal flexure, where the amount of fat is so small that semi-translucent areas or *peritoneal windows* are recognisable between the loops of anastomoses formed by the jejunal branches of the superior mesenteric artery; near the lower part of the ileum, where the fat is more abundant, the "windows" cannot be seen. The difference is taken advantage of by the operating surgeon who wishes to know whether he is dealing with an upper or a lower coil of the small intestine.

Occasional Peritoneal Fossæ.—Before the dissection of the mesentery is commenced the dissector should look for certain peritoneal fossæ which are occasionally present. Some of the fossæ lie near the terminal part of the duodenum, others near the termination of the ileum, and one is associated with the root of the pelvic meso-colon.

The chief fossæ in the region of the duodenum are the *duodeno-jejunal*, the *superior duodenal*, the *inferior duodenal*, the *para-duodenal*, and the *retro-duodenal*.

The *duodeno-jejunal* or meso-colic *fossa* lies immediately above the duodeno-jejunal flexure of the small intestine and passes upwards into the root of the transverse meso-colon. The *superior* and the *inferior duodenal fossæ* lie at the left side of the terminal portion of the duodenum, the upper passing upwards and the lower passing downwards. The *para-duodenal fossa* lies a little more to the left. It is a pouch of peritoneum pushed laterally behind the inferior mesenteric vein, and its mouth looks towards

the terminal part of the duodenum. The *retro-duodenal fossa* passes upwards behind the terminal part of the duodenum.

The fossæ in the region of the ileo-cæcal junction are the *anterior ileo-cæcal*, the *posterior ileo-cæcal*, and the *retro-cæcal* or retro-colic. The anterior ileo-cæcal fossa lies behind a small fold of peritoneum which crosses the front of the ileo-cæcal junction. Its mouth is directed downwards and to the left. The inferior ileo-cæcal fossa also opens towards the left. It is bounded to the right by the cæcum, in front by the terminal part of the ileum and the adjacent part its mesentery, behind by the mesentery of the vermiform process, and below by the *plica ileo-cæcalis*, a fold of peritoneum which passes from the lower border of the ileum to the anterior surface of the mesentery of the vermiform process or, sometimes, to the process itself. The *retro-cæcal* or retro-colic fossa passes upwards behind the upper part of the cæcum and the lower part of the ascending colon; when this fossa is present the vermiform process usually lies in it.

The *inter-sigmoid fossa* also should be looked for at this stage, in order that, if it is present, its boundaries may be examined before they are interfered with by dissection. It runs upwards behind the root of the pelvic meso-colon, at the left side of the last lumbar vertebra. To find it, turn the pelvic part of the colon upwards.

Dissection.—After the occasional peritoneal fossæ which happen to be present have been examined make an incision through the peritoneum of the right side of the root of the mesentery, from its upper to its lower end, and reflect the right layer of the mesentery towards the gut from above downwards. As the reflection proceeds take away the fat which lies between the two layers and clean the structures which are exposed. They are—(1) the trunk of the superior mesenteric artery surrounded by the superior mesenteric plexus of nerves, lying along the root of the mesentery; (2) the superior mesenteric vein, which lies usually to the right of the artery; (3) the intestinal branches of the superior mesenteric artery, passing to the wall of the gut; (4) the accompanying veins, nerves, and lymph vessels; and (5) the mesenteric lymph glands, which lie in the intervals between the blood-vessels; they are scattered at varying distances from the border of the gut to the superior mesenteric trunk in the root of the mesentery.

After the structures which lie between the two layers of the mesentery have been cleaned make an incision through the peritoneum on the posterior wall of the abdomen from the upper end of the root of the mesentery to the upper end of the ascending colon, then reflect the peritoneum, below the level of the incision, downwards and to the right to the medial margin of the ascending colon and the ileo-cæcal junction. Now clear away the extra-peritoneal fat which is displayed, and expose the structures which lie on the posterior wall of the abdomen between the root of the mesentery and the ascending colon. Most superficially, immediately behind the peritoneum, will be found the right colic and ileo-colic branches of the superior mesenteric artery, with the accompanying veins, nerves, lymph vessels and glands. In the upper part of the region, directly below the root of the transverse meso-colon, the lower part of the descending portion and the right part of the inferior portion of the duodenum will be found, with the superior mesenteric artery and vein, crossing in front of the inferior portion. Behind

PLATE XV

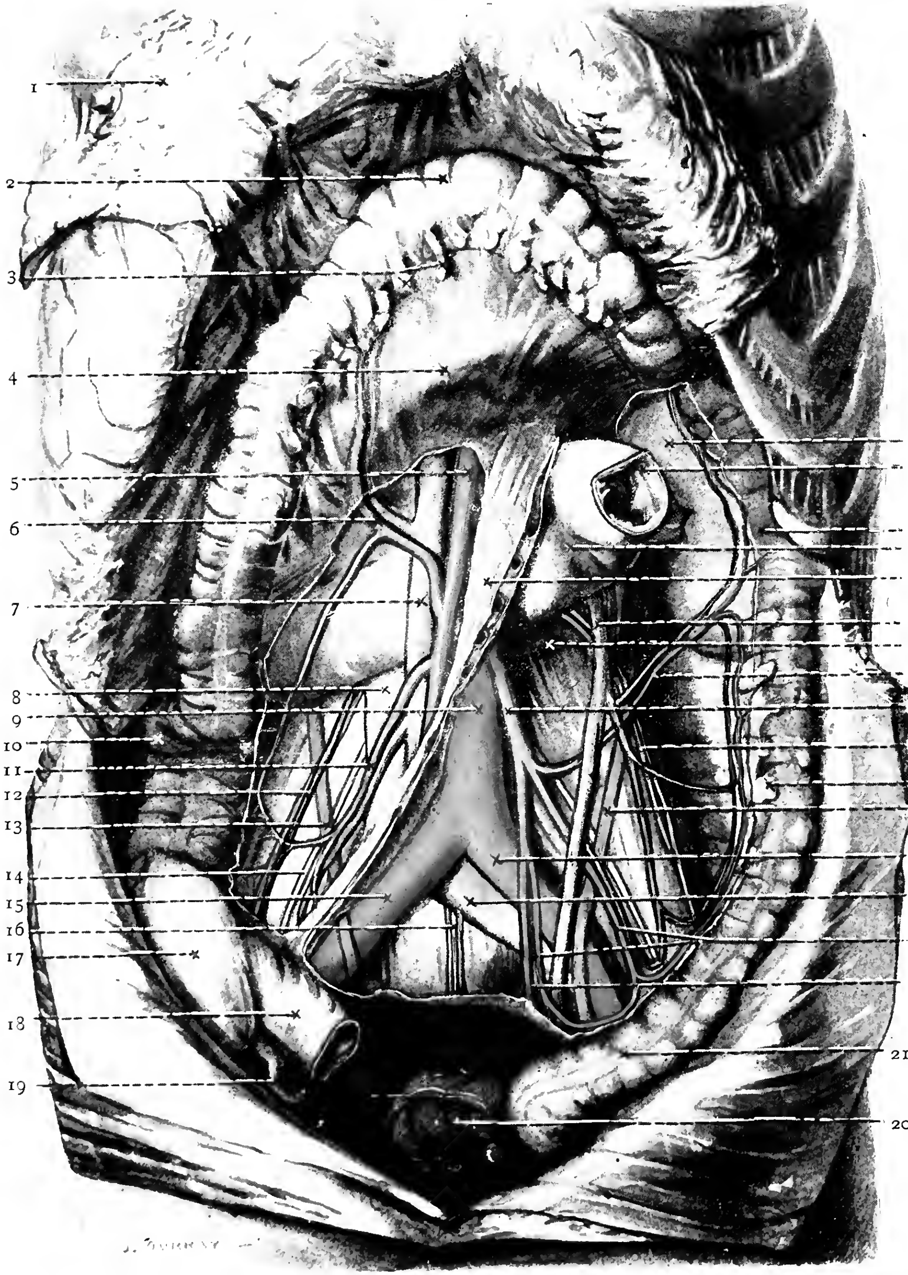

FIG. 146.

PLATE XV

FIG. 146.—Dissection of the lower part of the Abdomen.

The greater omentum and the transverse colon have been turned upwards.

The small intestine has been removed, and the peritoneum and extra-peritoneal fat have been dissected away from the structures on the posterior wall of the abdomen below the level of the transverse meso-colon.

1. Greater omentum.
2. Transverse colon.
3. Appendices epiploicæ.
4. Transverse meso-colon.
5. Superior mesenteric artery.
6. Middle colic artery.
7. Superior mesenteric vein.
8. Inferior vena cava.
9. Aorta.
10. Right flexure of the colon.
11. Common trunk of right and ileo-colic arteries.
12. Internal spermatic vessels.
13. Ureter.
14. Genito-femoral nerve.
15. Right common iliac artery.
16. Middle sacral vessels.
17. Cæcum.
18. Ileum.
19. Vermiform process.
20. Pelvic colon.
21. Iliac colon.
22. Superior hæmorrhoidal artery.
23. Sigmoid arteries.
24. Left common iliac vein.
25. Left common iliac artery.
26. Ureter.
27. Descending colon.
28. Internal spermatic vessels.
29. Inferior mesenteric artery.
30. Left colic artery.
31. Psoas major muscle.
32. Inferior mesenteric vein.
33. Mesentery of small intestine (cut).
34. Duodeno-jejunal flexure.
35. Left flexure of the colon.
36. Jejunum.
37. Left kidney.

the superior mesenteric artery, at a lower level, is a part of the aorta, and to the right of the aorta is the inferior vena cava. Partly behind the duodenum and partly to the right of it, on a posterior plane, is the lower pole of the right kidney. The right ureter emerges from behind the duodenum and passes downwards on its way to the brim of the pelvis minor along the medial border of the lower pole of the kidney, and then behind the ileo-colic and the superior mesenteric arteries. The internal sper-

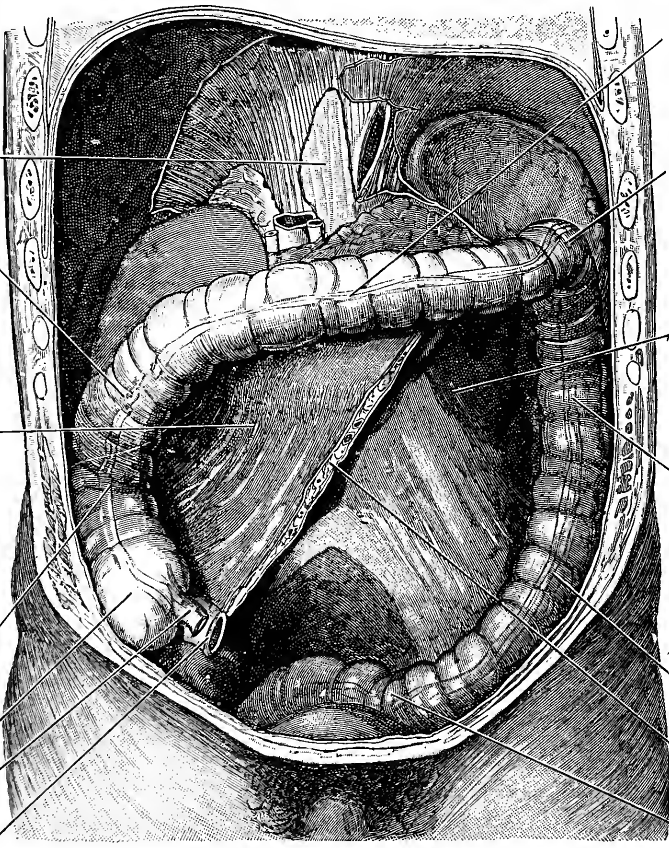

FIG. 147.—Abdomen after removal of Liver, Stomach, Jejunum and Ileum.

matic vessels cross in front of the ureter (Fig. 146), and the genito-femoral nerve passes downwards and laterally, behind the ureter, on the anterior surface of the psoas major muscle. Beyond the lateral border of the psoas major the fascia on the anterior surface of the quadratus lumborum will be exposed.

When the structures mentioned have been cleaned make an incision through the lower layer of the transverse meso-colon, from the upper end of the root of the mesentery to the transverse colon; then reflect the part of the lower layer of the transverse meso-colon which lies to the right of the incision towards the transverse colon. As the reflection proceeds the trunk and branches of the middle colic artery and the accompanying veins,

nerves, lymph vessels and lymph glands will be exposed, and the anastomoses of the branches of the middle colic artery with branches of the right colic artery will be displayed.

After the structures in the right part of the transverse meso-colon have been secured and cleaned throw the small intestine over to the right side and make two incisions through the peritoneum on the left part of the posterior wall of the abdomen; one, a transverse incision, from the upper end of the root of the mesentery to the upper end of the descending colon, and the other along the left side of the root of the mesentery from its upper to its lower end. After the incisions have been made reflect the left half of the lower layer of the transverse meso-colon towards the transverse colon and display the anastomoses of the left branches of the middle colic artery with the upper branches of the left colic artery, and the associated veins, lymph vessels, lymph glands and nerves. When those structures have been cleaned reflect the peritoneum on the left part of the posterior wall of the abdomen downwards and to the left. When the reflection is completed and the extra-peritoneal fat has been removed the dissector will find that he has exposed a greater number of structures than he did when he removed the peritoneum covering the posterior wall of the abdomen to the right of the root of the mesentery. In the median plane, below the root of the mesentery, lies the lower part of the abdominal portion of the aorta, dividing, opposite the fourth lumbar vertebra, into the two common iliac arteries, each of which is continued downwards into the corresponding external iliac artery. On the surface of the aorta is the aortic plexus of nerves, which must be carefully preserved. To the right of the aorta is the lower part of the inferior vena cava, and to the right of and below the left common iliac artery is the left common iliac vein. Springing from the front of the aorta, about one and a half inches above its bifurcation and to the left of the median plane, is the inferior mesenteric artery. The inferior mesenteric artery runs downwards on the left of the aorta to the left common iliac artery, where it becomes the superior hæmorrhoidal artery. Before it becomes the superior hæmorrhoidal it gives off the left colic branch, and two or more sigmoid branches. The left colic branch passes to the left, towards the descending colon, and divides into an ascending and a descending branch, which run towards the upper and the lower parts of the descending colon respectively. The sigmoid branches run downwards and laterally towards the lower part of the iliac colon. To the left of the inferior mesenteric artery is the inferior mesenteric vein, which ascends to the root of the transverse meso-colon. As it ascends it crosses behind the left colic artery and in front of the internal spermatic vessels; when it reaches the root of the transverse meso-colon it disappears behind the lower border of the pancreas, which is exposed in the upper part of the area under consideration. To the left of the lower part of the inferior mesenteric vein are the internal spermatic vessels, which pass behind the sigmoid and left colic arteries, or their branches, and then behind the inferior mesenteric vein; they also disappear above behind the pancreas. In the upper and left angle of the area, in the concavity of the left flexure of the colon, is the lower part of the left kidney, and, descending along its medial border, the

left ureter, which passes downwards, behind the internal spermatic vessels and the left colic and sigmoid arteries, to the lower end of the left common iliac artery. Running downwards and laterally behind the left ureter, on the front of the left psoas major muscle, is the left genito-femoral nerve, and beyond the lateral border of the left psoas is the fascia on the front of the medial part of the left quadratus lumborum. Along the anterior border of the psoas, at the left of the aorta, is the left sympathetic trunk. The right sympathetic trunk is concealed by the inferior vena cava.

When the dissector has found and defined all the structures mentioned, he should commence the study of the superior and the inferior mesenteric arteries and their branches. He will find that the superior mesenteric supplies the terminal portions of the duodenum, the whole of the jejunum and the ileum, the cæcum, the ascending colon and the greater part of the transverse colon; that the inferior mesenteric supplies the left part of the transverse colon, the left flexure of the colon, the descending colon, the iliac colon, and the pelvic colon, and that it furnishes also the greater part of the blood supply of the rectum, by means of its continuation—the superior hæmorrhoidal artery. He will find also that there is a very free anastomosis between the left colic branch of the inferior mesenteric artery and the middle colic branch of the superior mesenteric artery. At a later period he will find that an inferior pancreatico-duodenal branch of the superior mesenteric artery anastomoses with the superior pancreatico-duodenal branch of the gastro-duodenal artery, and when he recalls to mind the fact that the gastro-duodenal artery is a branch of the hepatic, and that it furnishes the right gastro-epiploic, which passes to the stomach and anastomoses on its surfaces with the other arteries which supply that viscus, he will recognise that a complete chain of arterial anastomoses runs along the wall of the abdominal part of the alimentary canal, providing for the continuance of the blood supply to the wall of the gut in the event of one or more of the bigger trunks being temporarily or permanently occluded.

Arteria Mesenterica Superior.—The superior mesenteric artery springs from the front of the abdominal aorta about 6.5 mm. (quarter of an inch) below the cœliac artery. At its origin it is covered by the neck of the pancreas, and it is crossed by the splenic vein. After it emerges from under cover of the neck of the pancreas, it proceeds downwards, in front of the lower portion of the head of the pancreas; then it crosses the inferior part of the duodenum, to the right of the duodeno-jejunal flexure, and enters the root of the mesentery proper, along which it proceeds to the right iliac fossa, where it ends by anastomosing with one of its own branches. Between its extremities it is slightly curved, the convexity of the curve being directed to the left. It is accompanied by the superior mesenteric vein, which lies upon its right side,

and by the superior mesenteric plexus of nerves, which surrounds it.

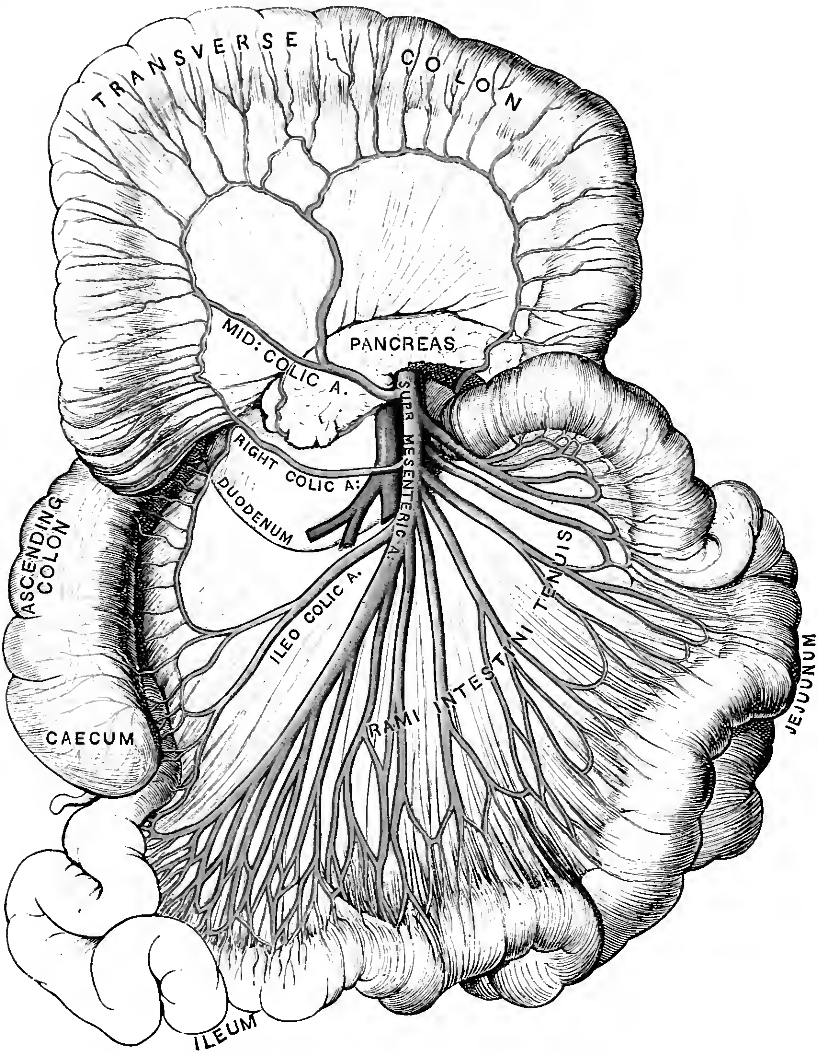

FIG. 148.—Dissection of the Superior Mesenteric Artery.

It gives off the following branches :—

Aa. Intestinales	A. pancreatico-duodenalis inferior.	
	Aa. jejunales	to jejunum and ileum.
	Aa. ileæ	
	A. ileocolica	to large intestine.
	A. colica dextra	
	A. colica media	

Arteria Pancreatico - duodenalis Inferior.—The inferior

pancreatico-duodenal branch takes origin from the upper part of the superior mesenteric artery, or from its first intestinal branch, and passes upwards and to the right behind the head of the pancreas. It gives branches both to the duodenum and to the pancreas, and anastomoses with the superior pancreatico-duodenal artery.

Arteriæ Jejunales et Ileæ.—The jejunal and ileal branches spring from the convexity or left side of the superior mesenteric, and proceed obliquely downwards and to the left, between the layers of the mesentery, to supply the jejunum and ileum. They are very numerous—from twelve to fifteen, or even more, in number—and, by the inosculations of their branches, they form a very remarkable succession of arches between the layers of the mesentery. At first they run parallel to one another; but soon each divides into two branches which join the immediately adjacent branches of the neighbouring stems, and in that way a series of *arterial arcades* is formed. From the primary arcades smaller vessels proceed, which divide and unite, in a similar manner, to form a second series of arches; and so on, until three, four, or perhaps even five, tiers of arterial arcades are produced. From the most peripheral arches numerous small branches pass directly to the wall of the intestine. At the intestine, along the line of mesenteric attachment, they divide, and the minute twigs, thus derived, pass transversely round the gut so as to encircle it. At first they lie immediately subjacent to the peritoneal coat of the bowel, but soon they seek a deeper plane in the wall of the intestine, and ultimately after passing through the muscular coats their terminal branches reach the submucous coat. The number of arterial arcades which intervene between the primary and terminal branches increases towards the lower part of the small intestine (Fig. 148).

Arteria Ileocolica.—The ileo-colic artery springs from the middle of the concavity of the superior mesenteric, and proceeds downwards and laterally towards the right iliac fossa. It is placed behind the parietal peritoneum, and divides into an ascending and a descending or ileo-cæcal branch. The *ascending branch* turns upwards, inosculates with a branch of the right colic, and from the arterial arch thus formed branches are given to the ascending colon. The *descending branch*, sometimes called the *ileo-cæcal artery*, proceeds to the upper part of the ileo-cæcal junction and sends branches in

different directions. Two, termed the *anterior* and *posterior cæcal arteries*, pass respectively to the front and back of the cæcum; one, a slender vessel, the *artery to the vermiform process*, runs downwards behind the terminal part of the ileum and supplies the vermiform process, which it reaches by passing between the layers of the mesentery of that process; a fourth, the *ileal artery*, turns to the left along the ileum, it forms a loop with the termination of the superior mesenteric trunk.

Arteria Colica Dextra.—The right colic artery arises together with, or above, the ileo-colic, and passes to the right, behind the parietal peritoneum on the posterior wall of the abdomen. It divides into two branches, a superior and an inferior. The *superior branch* ascends, and at the right colic flexure it passes between the two layers of the transverse meso-colon to inosculate with the middle colic; whilst the *inferior branch* joins the ascending branch of the ileo-colic artery. From the convexity of the arches twigs proceed to the ascending colon, the right flexure of the colon, and part of the transverse colon.

Arteria Colica Media.—The middle colic artery springs from the upper part of the superior mesenteric. It passes, at once, between the two layers of the transverse meso-colon, and divides into a right and a left branch. The *right branch* joins the superior part of the right colic, whilst the *left branch* inosculates with the ascending part of the *left colic artery*, which is derived from the inferior mesenteric. Arterial arcades are thus formed in the transverse meso-colon, from which branches proceed for the supply of the transverse colon. Some of the branches pass beyond the transverse colon and descend between the two posterior layers of the great omentum.

Vena Mesenterica Superior.—The superior mesenteric vein is a large vessel which lies to the right of the superior mesenteric artery. It receives tributaries from those parts of the intestinal canal supplied by branches from the superior mesenteric artery; it also receives the right gastro-epiploic vein, from the greater curvature of the stomach, and the pancreatico-duodenal vein. It passes upwards, in front of the inferior part of the duodenum, and, leaving the root of the mesentery, disappears behind the neck of the pancreas, where it unites with the splenic vein to form the *vena portæ*.

Plexus Mesentericus Superior.—The superior mesenteric plexus is a dense plexus of sympathetic nerve twigs which

surrounds the superior mesenteric artery like a sheath. From it filaments are prolonged to the intestine along the various branches of the artery. As the nerves approach the bowel, some of the twigs leave the vessels and effect a series of communications with each other in the intervals between the arteries.

The superior mesenteric plexus is an offshoot from the *cœliac plexus*, and it distributes twigs to the jejunum and ileum, and to the right half of the large intestine.

Lymphoglandulæ Mesentericæ.—The mesenteric lymph glands are very numerous—indeed, considerably over a hundred in number. They lie between the layers of the mesentery and, in health, they rarely attain a size greater than that of a small bean, whilst they may be as small as a pin head. They form three main groups. First, a series of juxta-intestinal glands, situated near the gut; next, an intermediate group, associated with the larger branches of the jejunal and ileal arteries; and thirdly, a group of large glands placed close to the trunk of the superior mesenteric artery.

The *lacteals*, which are the lymph vessels of the intestine, issue from the wall of the gut in enormous numbers. They also form a series of relays. First, those which pass from the intestine to the juxta-intestinal glands; secondly, those which connect the various glands together; and finally, a group of efferent vessels, from the largest glands, which fuse together to form a *common intestinal trunk*. The common intestinal trunk terminates in the cisterna chyli, which will be displayed in a later dissection.

Lymph glands are also found on the walls of the large intestine, along its concave border, and in association with the branches of the arteries which supply it. The lymph from the cæcum, the vermiform process, the ascending colon, and the transverse colon passes to the common intestinal trunk, through lymph vessels which accompany the arteries of supply to the parts named, and so to the cisterna chyli. The lymph from the descending colon, the iliac colon, and the pelvic colon passes along vessels and through the lymph glands associated with the branches and the trunk of the inferior mesenteric artery, and thence to the lumbar glands, whence it is conveyed to the cisterna chyli.

Arteria Mesenterica Inferior.—The inferior mesenteric artery, considerably smaller than the superior mesenteric,

springs from the left side of the front of the abdominal aorta, about 37·5 mm. (an inch and a half) above its termination. It descends, with a slight inclination to the left, to the brim of the pelvis minor, where it crosses the left common iliac

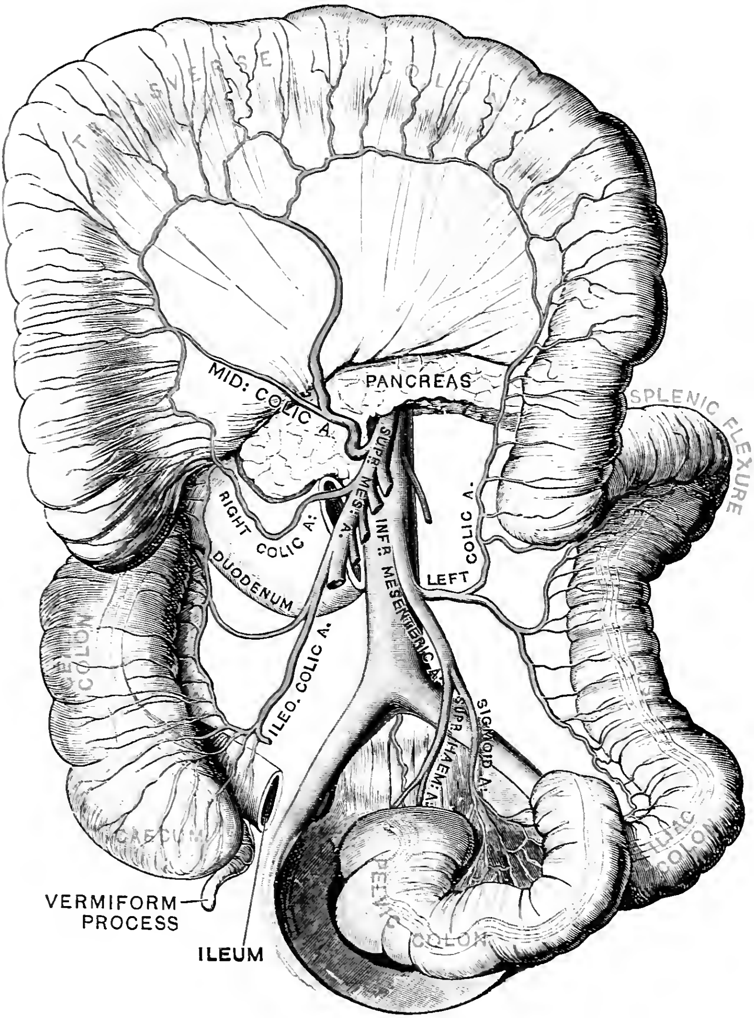

FIG. 149.—Dissection of the Inferior Mesenteric Artery

artery and becomes the *superior hæmorrhoidal artery*, which descends into the pelvis minor. Before the inferior mesenteric artery reaches the left common iliac artery it gives off the left colic and the sigmoid branches.

Arteria Colica Sinistra.—The left colic artery runs to the left and divides into two branches, of which one ascends,

in front of the lower part of the left kidney, to the transverse meso-colon, where it inosculates with the middle colic artery. The other descends, behind the peritoneum of the posterior wall of the abdomen, to unite with the superior sigmoid artery. From the arches thus formed twigs are supplied to the transverse colon, the left flexure of the colon, and the descending colon. The point of division into upper and lower branches is very variable.

Arteriæ Sigmoideæ.—The sigmoid arteries, one to three in number, are distributed to the lower part of the descending colon, the iliac colon, and the pelvic colon. The highest branch enters the left iliac fossa, behind the parietal peritoneum. It sends a branch upwards to form an arch with the descending branch of the left colic, and another downwards, which ultimately enters the pelvic meso-colon and joins the other sigmoid branches. The lower sigmoid arteries pass into the pelvic meso-colon, and there form a series of arcades, varying in number according to the length of that mesentery; from those arcades the twigs for the supply of the pelvic colon are given off.

The *superior hæmorrhoidal artery* will be followed out in the dissection of the pelvis minor.

Vena Mesenterica Inferior.—The inferior mesenteric vein receives tributaries corresponding with the branches of the inferior mesenteric artery. It passes upwards, upon the psoas major muscle, under cover of the peritoneum, to the left of, and at some distance from, the artery, and, after disappearing behind the pancreas, it ends in the splenic vein.

Plexus Mesentericus Inferior.—The *inferior mesenteric plexus of nerve fibres* is an offshoot from the left side of the aortic plexus. It closely surrounds the artery, and sends twigs along the branches of the vessel to supply the left half of the large intestine.

Plexus Aorticus Abdominalis.—The abdominal aortic nerve plexus is placed upon the aorta, between the origins of the two mesenteric arteries. It is more strongly marked upon the sides of the artery than in front of it. Its continuity, above, with the cœliac and renal plexuses, will be demonstrated at a later stage of the dissection. From its lower extremity several large branches descend, in front of the common iliac arteries, to join the hypogastric plexus—a plexus which is situated in front of the fifth lumbar

vertebra. Upon each side the aortic plexus is reinforced by several small twigs from the gangliated trunk of the sympathetic. The *inferior mesenteric plexus*, accompanying the artery of that name, and the *internal spermatic* (or *ovarian*) *plexus* of nerves, which accompanies the internal spermatic (or *ovarian*) artery, are offsets from the aortic plexus.

Dissection.—Removal of the Jejunum and Ileum.—Apply two ligatures round the jejunum about an inch below the duodeno-jejunal flexure, and divide the gut between them; next, place two ligatures round the ileum, about six inches from its union with the large intestine, and divide it in like manner; then cut through the blood-vessels and the remains of the mesentery close to the wall of the gut, and remove the separated portion. Take the detached portion of the gut to the sink, cut away the ligatures, and clean the cavity of the gut by allowing water from the tap to run through it.

The coats of the small intestine must be dissected under water. Take a few inches from the upper end of the jejunum, and, having opened it up with the scissors along the line of mesenteric attachment, pin it out, with its mucous surface downwards, upon the bottom of a cork-lined tray which has been previously filled with clean water. The jejunum is chosen because its wall is thicker than that of the ileum, and consequently is more easily dissected. Carefully remove the thin serous coat, in order that the subjacent layer of longitudinal muscular fibres may be studied. Then turn the specimen round and pin it down with its mucous surface uppermost. Now remove the mucous membrane and the subjacent flocculent submucous coat, with the scissors, in one layer. The circular muscular fasciculi will then come into view.

Structure of the Small Intestine.—The wall of the small intestine is composed of five coats or strata, viz. :—

1. Serous.
2. Subserous.
3. Muscular.
4. Submucous.
5. Mucous.

The *serous coat* of the jejunum and ileum is complete, except along the line of the mesenteric attachment. It is exceedingly thin—much thinner than the layers of the mesentery with which it is continuous. Unless great care is taken in stripping it off, some of the subjacent muscular fibres will be taken away with it. The *subserous coat* is a scarcely appreciable amount of areolar tissue which intervenes between the peritoneum and the muscular coat and connects them together. The *muscular coat* is composed of involuntary, non-striated muscular fibres, which are disposed in two layers, viz., an *external stratum* of longitudinal fibres,

and an *internal stratum* of circular fibres. The circular layer is the thicker and more distinct of the two. The external longitudinal fibres are spread out, in the form of a thin continuous layer, all round the circumference of the intestine, but the layer is thickest in that part of the wall which is furthest from the mesenteric attachment. The *submucous coat* is composed of loose areolar tissue which binds the muscular to the mucous coat. It is more firmly connected with the latter than the former. The *mucous coat* must be examined throughout the whole length of the jejunum and ileum.

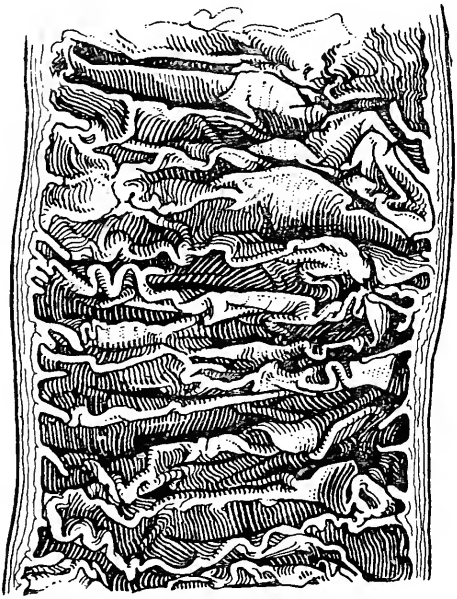

FIG. 150.—Typical part of Jejunum, showing numerous and large Plicæ Circulares.

Dissection.—It has already been noted that little distinction can be drawn between the upper and lower parts of the small intestine from their external appearances, beyond the fact that as the intestine descends it diminishes slightly in calibre and its walls diminish in thickness (cp. p. 273). The internal appearances of the upper part of the jejunum and the lower part of the ileum, on the other hand, are very different, and the small intestine must now be opened in order that the internal difference may be investigated. In the first place, however, remove about 30 cm. (twelve inches) of the upper part of the jejunum; ligature it at both ends and distend it with air by means of a blow-pipe; then hang it up to dry, in order that the folds of the mucous membrane, called *plicæ circulares*, may be investigated in their entirety. The best way to open the remainder of the small intestine is to tie a ligature round the lower cut end of the ileum and then fill the gut as full as possible with water. When that has been done take the scissors and impale a small piece of costal cartilage on the point of one blade. Introduce the blade, so protected, into the gut and run the scissors downwards along the line of the attachment of the mesentery. If the procedure described is followed the gut will easily be laid open from end to end.

Mucous Membrane of the Small Intestine.—The *plicæ circulares* (O.T. *valvulæ conniventes*) are the most conspicuous objects

on the inner wall of the small intestine. They are folds of the mucous membrane placed more or less transversely to the long axis of the intestine. Note particularly that they are *permanent folds*, and that no amount of stretching or distension of the walls will cause their obliteration. On careful study of the dried specimen three main varieties of plicæ circulares may be recognised. The great majority are in the form of crescentic folds, which extend for a variable distance round the wall of the intestine; others form complete rings around the interior; the third variety, usually the least numerous, are arranged in a spiral manner, and take from one to three spiral turns around the wall of the intestine. Each fold consists of two layers of mucous membrane, with a little intervening areolar tissue derived from the submucous coat. The other coats of the intestine take no part in the formation of the plicæ circulares. In the upper part of the jejunum the plicæ circulares are strongly developed, and placed so closely together that the intervals between them are hardly greater than the thickness of one of the folds. Lower down, however, the plicæ gradually diminish in numbers, become more widely separated, more oblique in their direction, and not nearly so large. Towards the middle of the ileum, they become few and far between, and a little beyond that point they usually disappear altogether (Figs. 150, 151).

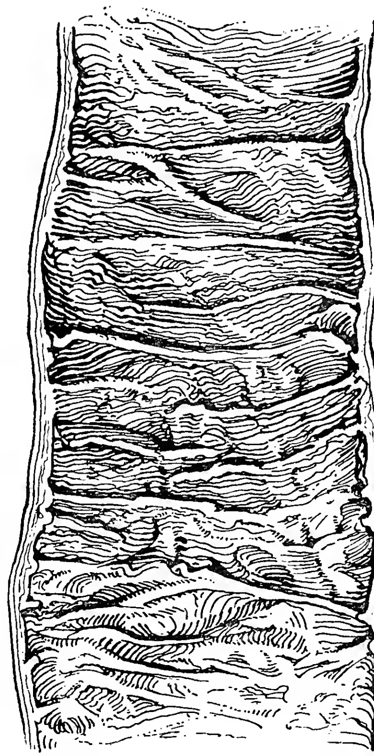

FIG. 151.—Typical part of Ileum, showing few and small Plicæ Circulares.

The chief function of the plicæ circulares is to increase the absorbing and secreting surface of the small intestine.

Another characteristic of the mucous lining of the small intestine is the presence of *villi*. They are minute projec-

tions of the mucous membrane, varying in length from about .8 to .6 mm. ($\frac{1}{30}$th to $\frac{1}{40}$th of an inch). They occur in enormous numbers over the entire extent of the inner surface of the intestine, not only upon the plicæ circulares, but also in the intervals between them, and they give to the mucous membrane a velvety or fleecy appearance.

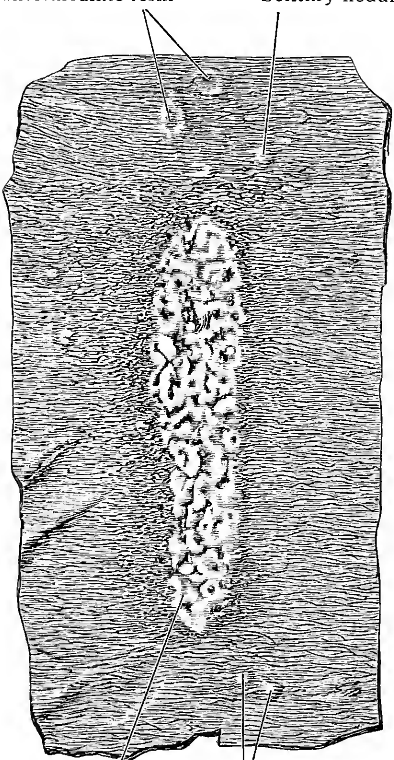

FIG. 152.—Aggregated Lymph Nodule and Solitary Lymph Nodules from the intestine of a child of two years old. (Birmingham.)

To obtain a proper view of the villi float out a portion of the small intestine in water, after it has been carefully cleansed from adhering mucus, and examine it with an ordinary pocket-lens. If a portion of the upper end of the jejunum is placed side by side with a portion of the lower part of the ileum, and the two are contrasted, the student will readily detect that the villi are, if anything, larger and decidedly more numerous in the jejunum than in the ileum. They diminish gradually in number and in size from above downwards.

Noduli lymphatici aggregati et noduli lymphatici solitarii.—Aggregated lymph nodules (O.T. *Peyer's patches*) and solitary lymph nodules must also be looked for. Frequently they are difficult to find, but if the bowel is held up to the light they can generally be detected. When seeking aggregated lymph nodules it is best to examine the ileum from below upwards.

An *aggregated lymph nodule* consists of a large number of lymph follicles grouped together so as to present to the eye a patch of an elongated, oblong outline. The nodules are placed upon that aspect of the intestine which is opposite to the line of the mesenteric attachment, and the long axis of

each corresponds in its direction with that of the intestine itself.

In the lower part of the ileum the aggregated nodules may be from 25 mm. to 100 mm. (1 to 4 inches) long, and 12.5 mm. (half an inch) broad, but higher in the ileum they become much smaller and not nearly so numerous, and they are either few in number, or entirely absent, in the jejunum. The total number varies much, but the average number may be stated to be about thirty. They are more numerous in the young, and not so abundant nor so distinctly marked out in later periods of life. Indeed, in very old subjects they may disappear almost entirely.

The *solitary lymph nodules* are isolated lymph follicles, scattered everywhere in the mucous membrane of the small intestine. They are minute, rounded or ovoid, opaque white bodies, about the size of a millet seed, and they usually cause a slight bulging of the mucous membrane at the points where they occur.

The *plicæ circulares*, the *villi*, and *aggregated lymph nodules* are the only special peculiarities of the mucous membrane of the jejunum and ileum which are visible to the naked eye; and, from what has been said regarding them, the dissector will understand that, although they are not arranged in such a way as to mark off the jejunum from the ileum by a clear line of demarcation, they are sufficient to enable him to distinguish between characteristic portions of each—*i.e.* between portions taken at some distance from the arbitrary line of division. The following are the essential points of difference which should guide him in deciding which is ileum and which jejunum:—

JEJUNUM.	ILEUM.
Plicæ Circulares.	
Numerous and well marked.	Few in number and poorly developed, and, in its lower part, absent altogether.
Villi.	
Numerous and large.	Not so numerous and not so large.
Aggregated Lymph Nodules.	
Few in number, small in size, and, as a rule, nearly circular in outline.	More numerous, of large size, and oblong in form.

The general position and the constituent portions of the

large intestine have already been noted (p. 274); the positions and relations of the individual parts must now be studied more completely.

Intestinum Crassum.—The total length of the large intestine varies from 134 to 167 cm. ($4\frac{1}{2}$ to $5\frac{1}{2}$ feet). The cæcum, which is the shortest segment, is 64 mm. ($2\frac{3}{4}$ inches) long, and as broad, or broader, than it is long. The ascending colon is from 12.5 cm. to 20 cm. long (5 to 8 inches). The transverse colon, which is the longest segment, is from 47.5 to 50 cm. in length (19 to 20 inches). The descending colon is somewhat shorter than the ascending colon, varying from 10 to 15 cm. (4 to 6 inches) in length. The iliac colon varies from 12.5 to 15 cm. (5 to 6 inches) in length; it is, therefore, slightly longer than the descending colon. The length of the pelvic colon varies very considerably, but averages from 40 to 42.5 cm. (16 to 17 inches). The rectum is the same length as the iliac colon, 12.5 to 15 cm. (5 to 6 inches). The pars analis recti, or anal canal, which forms the terminal segment of the large intestine, is from 25 mm. to 37.5 mm. (1 to $1\frac{1}{2}$ inches) long. The measurements given are those which have been estimated on formol-hardened bodies, in which the walls of the intestines are more or less contracted; they are, therefore, minimal measurements, and the lengths of the various segments will be found to be greater in unhardened bodies, such as those met with in the post-mortem room.

The walls of all parts of the large intestine, except the anal canal, are sacculated, but the sacculations vary in size and number in the different segments, being largest and least numerous in the rectum. During life, and after death, the descending colon, the iliac colon, and the anal canal are usually empty and their walls are contracted; but the walls of the other portions of the large gut are usually flaccid, even when they are not distended.

Intestinum Cæcum.—The cæcum is the first section of the large gut. It has the appearance of a sacculated pouch, 65 to 70 mm. (2 or 3 inches) long. Its width varies, but is rarely less than its length, and it may be a little greater. It is continuous, above, with the ascending colon, and on the left, with the ileum, and with the vermiform process, which, in the adult, is a diverticulum from the cæcum. It is completely clothed

with peritoneum, and is supplied with blood by branches derived from the loop between the termination of the superior mesenteric artery and its ileo-colic branch.

Processus Vermiformis (O.T. **Vermiform Appendix**).—The vermiform process springs from the medial and posterior aspect of the cæcum, about 25 mm. (1 inch) below the ileo-cæcal junction. It passes either upwards and to the left, towards the left hypochondrium, or downwards into the pelvis minor, across the right external iliac artery, or upwards behind

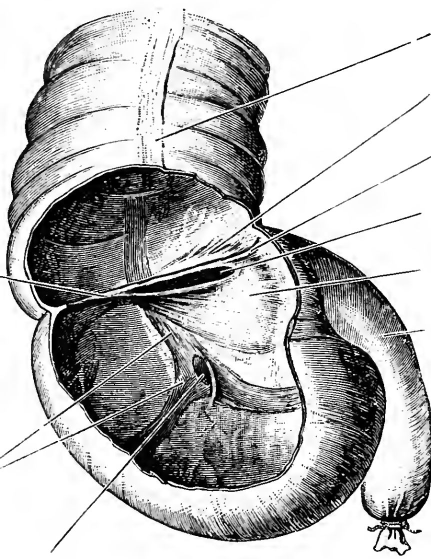

FIG. 153.—Cæcum which has been distended with air and dried, and then opened to show Ileo-Cæcal Opening and Colic Valve. (Birmingham.)

the cæcum and the ascending colon. It usually occupies the last position if a retro-colic pouch is present. It is attached, by the *mesentery of the vermiform process*, to the posterior surface of the lower part of the mesentery of the ileum.

Dissection.—Turn the cæcum upwards; remove the peritoneum from the wall of the iliac fossa behind it, and take away the extra-peritoneal fat. Note that the peritoneum and fat separate the cæcum from the right psoas and iliacus muscles, and from the femoral nerve (O.T. anterior crural) which lies in the angle between the muscles. The anterior surface of the cæcum is in relation with the anterior wall of the abdomen, or is separated from it by the lower part of the greater omentum.

Cut away a portion of the right lateral wall of the cæcum and examine the ileo-cæcal orifice and the orifice of the vermiform process from the interior of the intestine.

The Ileo-Cæcal Orifice is an antero-posterior slit, bounded by two protruding lips, a superior and an inferior, which are formed by the partial invagination of the lower end of the ileum into the cæcum. The two lips are the two segments of the *valve of the colon* (O.T. *ileo-cæcal valve*). At the extremities of the orifice the segments of the valve unite together and become continuous with a ridge of the wall of the gut which is prolonged around the cavity. The anterior and posterior parts of the ridge, immediately adjacent to and connected with the lips of the valves, are spoken of as the *frenula of the valve.*

The peritoneum and the longitudinal muscular bands are

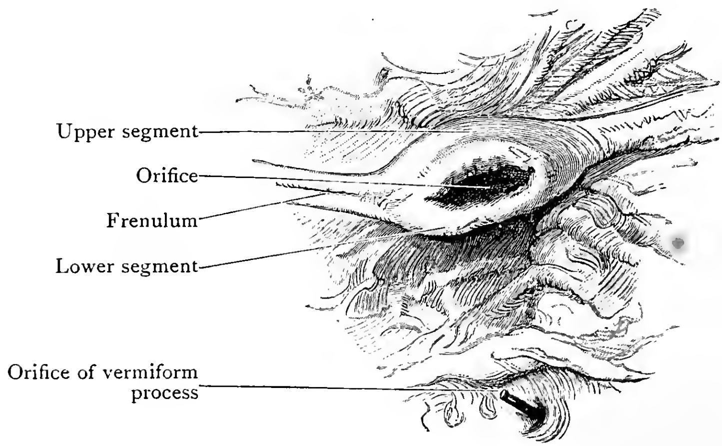

FIG. 154.—Ileo-Cæcal Opening and Valve of the Colon from a subject hardened by formalin injection. (Birmingham.)

in no way involved in the infoldings which form the valve-flaps; but some of the other constituents of the gut-wall (viz., the mucous membrane, the submucous coat, and the circular muscular fibres) take part in their formation. Villi are present on the ileal but not on the cæcal aspect of each valve-flap.

The function of the valve is obvious. It is so arranged that the free passage of materials from the ileum into the cæcum is in no way impeded; but when the cæcum becomes distended, and there is, consequently, a tendency to regurgitation, the frenula of the valve are put upon the stretch, and the free borders of the segments are brought into firm contact. In that way reflux of the contents of the cæcum into the

ileum is to some extent prevented, but it must be noted that the circular muscle layer at the end of the ileum plays the part of a definite sphincter muscle.

The position of the ileo-cæcal orifice is marked, on the anterior surface of the abdomen, by the lower medial angle between the intertubercular and the right lateral lines. About 25 mm. (1 inch) below the ileo-cæcal orifice, and on a posterior plane, is the orifice of the vermiform process, which may be quite open, or it may be partly guarded by a semilunar fold of mucous membrane, the *valve of the vermiform process.*

Colon Ascendens.—The ascending colon passes upwards from the cæcum, through the upper part of the right iliac fossa, and through the right lumbar region to the right flexure of the colon in the right hypochondriac region. It varies from about 12.5 to 20 cm. (five to eight inches) in length. It is covered in front and at the sides by peritoneum, which binds it to the posterior wall of the abdomen. Occasionally it is attached to the posterior abdominal wall by an *ascending meso-colon.* Anteriorly, it is either in contact with the anterior wall of the abdomen, or it is separated from the abdominaf wall by coils of small intestine and the right free margin ol the greater omentum.

Dissection.—**The peritoneum along the medial border of the ascending colon has already been divided. Now divide the peritoneum along the lateral border; then turn the cæcum and the ascending colon upwards, and remove the fatty areolar tissue which lies behind the colon. Note that the ascending colon lies anterior to the upper part of the right iliacus muscle, the crest of the right ilium, and, above the crest, in front of the fascia covering the right quadratus lumborum and the medial part of the aponeurosis of the origin of the right transversus abdominis. It is separated from the quadratus lumborum, however, not only by the anterior lamella of the lumbar fascia, but also by three nerves—the last thoracic, the ilio-hypogastric and ilio-inguinal. It is possible that the dissector will not be able to display the last thoracic nerve at this stage of the dissection.**

Flexura Coli Dextra (O.T. **The Hepatic Flexure**).—The right flexure of the colon lies in the right hypochondrium, below and somewhat behind the anterior part of the lower surface of the right lobe of the liver, to the right of the gall-bladder, and in front of the lower part of the right kidney. It is covered by peritoneum except on its posterior surface, which is attached to the kidney by loose areolar tissue.

Colon Transversum.—The transverse colon extends first

downwards and forwards and then upwards and backwards, from the right colic flexure, which is in contact with the under surface of the right lobe of the liver, in the right hypochondriac region, to the left colic flexure, which is in contact with the lower extremity of the spleen, in the left hypochondriac region. The lowest part of the curve usually crosses through the upper half of the umbilical region, and

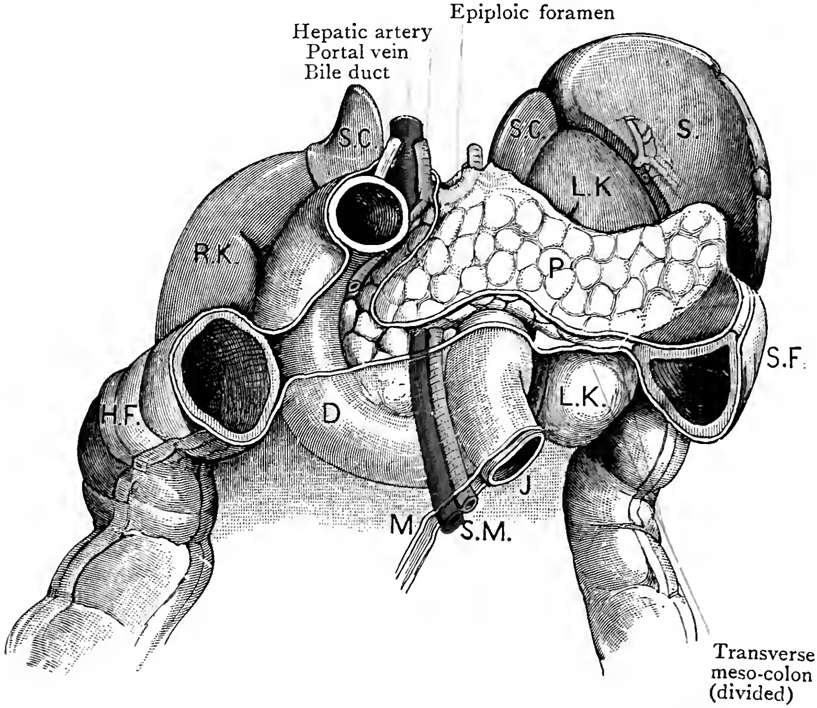

FIG. 155.—Duodenum, Pancreas, and Kidneys. (From the model by His.)

D.	Duodenum.	R.K.	Right kidney.
H.F.	Right flexure of the colon.	S.	Spleen.
J.	Jejunum.	S.C.	Suprarenal gland.
L.K.	Left kidney.	S.F.	Left flexure of the colon.
M.	Mesentery.	S.M.	Superior mesenteric vessels.
P.	Pancreas.		

a small but acute secondary curve, which is developed upon the left extremity of the main curve, lies against the medial border of the upper part of the descending colon. In the greater part of its extent it is enclosed in the posterior wall of the omental bursa, its lower border being attached to the greater curvature of the stomach by the greater omentum, whilst the posterior part of its upper border is attached to the

pancreas by the transverse meso-colon. At the right extremity of the transverse colon, however, the transverse meso-colon is absent, and the posterior part of the wall of the transverse colon lies directly against the descending part of the duodenum and the adjacent portion of the head of the pancreas (Fig. 155). Anteriorly the transverse colon is in relation from right to left, with the inferior surface of the right lobe of the liver; the lower part of the posterior surface of the gall-bladder; the cavity of the omental bursa and the anterior two layers of the greater omentum, which separate it from the abdominal wall and the abdominal surface of the diaphragm. It has already been pointed out that before it enters the posterior wall of the omental bursa, that is before the transverse meso-colon commences, its posterior surface is in direct relation with the anterior surface of the descending part of the duodenum and the adjacent part of the head of the pancreas; then it lies in front of the third part of the duodenum, the upper end of the mesentery of the small intestine, the duodeno-jejunal flexure, and, finally, in front of coils of jejunum, which separate it from the lower pole of the left kidney. Its lower border is attached to the posterior two layers of the greater omentum. The right extremity of its upper border is in relation to the inferior surface of the liver and the posterior surface of the gall-bladder, and, in the remainder of its extent, it is attached posteriorly by the transverse meso-colon to the pancreas, and anteriorly it embraces the lower part of the greater curvature of the stomach, behind the line of attachment of the greater omentum to the lower border of that viscus.

The Transverse Meso-colon is a fold of peritoneum which connects the posterior part of the upper border of the transverse colon to the front of the head and to the anterior border of the body of the pancreas. It is not so extensive as the transverse colon, and is absent to the right of the head of the pancreas, where the transverse colon is in direct contact with the second part of the duodenum. The lower layer of the transverse meso-colon has already been removed, but the upper layer and the arteries which lie between the two layers are still in position and will enable the dissector to verify the attachments of the fold, which contains the middle colic artery and its branches, the accompanying veins, nerves, lymph glands, and lymph vessels, and the terminal portions

of the upper branches of the right and left colic vessels and their anastomoses with the middle colic vessels.

Flexura Coli Sinistra (O.T. **The Splenic Flexure of the Colon**).—The left flexure of the colon is situated in the left hypochondriac region in close relation with the lower end of the spleen, the tail of the pancreas, and the lateral border of the left kidney. It is closely attached—(1) to the left extremity of the anterior border of the pancreas, by the left portion of the transverse meso-colon; (2) to the stomach, by the upper end of the left border of the greater omentum; (3) and to the abdominal surface of the diaphragm, opposite the eleventh rib in the mid-axillary line, by the phrenico-colic ligament. It is a more fixed flexure, and it is also a more acute flexure than the right flexure of the colon.

Colon Descendens.—The descending colon commences at the left flexure of the colon, in the left hypochondriac region, descends along the lower part of the lateral border of the left kidney, turns slightly medially to the apex of the lower pole of the kidney (Fig. 155), and then descends, vertically, to the left iliac crest, where it becomes the iliac colon. Its length varies from 10 to 15 cm. (four to six inches). Like the ascending colon it is covered in front and on each side by peritoneum, and its posterior surface is in relation with the extra-peritoneal fat which separates it from the fascia in front of the quadratus lumborum and the medial part of the aponeurosis of origin of the transversus abdominis. Its posterior and anterior relations are similar to those of the ascending colon (see p. 333).

Colon Iliacum.—The iliac portion of the colon commences at the termination of the descending colon, at the level of the upper and posterior part of the left iliac crest. It passes downwards and forwards to the region of the anterior superior iliac spine, and then turns medially, along the line of the inguinal ligament, to the brim of the pelvis minor, where it becomes the pelvic colon. Its length varies from 12.5 to 15 cm. (five to six inches). It does not possess a mesentery, but is covered with peritoneum anteriorly and along its sides. Posteriorly, it is separated by the extra-peritoneal fat from the iliacus, the psoas major, the femoral nerve (O.T. anterior crural), which lies in the groove between the two muscles, and its termination is in front of the left external iliac artery.

Before removing the ascending colon and the transverse

colon, the dissector should again examine the longitudinal muscle fibres of the walls of the large intestine. They are arranged in the form of three longitudinal bands (*tæniæ coli*). The bands converge together on the medial and posterior aspect of the cæcum and fuse into a continuous layer on the vermiform process. At the other end of the large gut they unite again, on the wall of the rectum, first into two bands and then into a continuous layer, but in the intervening parts of the large intestine the bands are widely separated, one running along the anterior border (*tænia libera*), one along the posterior border (*tænia mesocolica*), whilst the third lies along the medial borders of the ascending and descending portions of the colon, and along the lower border of the transverse colon (*tænia omentalis*).

Dissection.—Place two ligatures round the upper part of the ascending colon, immediately below the right flexure of the colon; divide the intestine between the ligatures and remove the cæcum and ascending colon. Place two ligatures round the transverse colon, to the left of the right flexure of the colon, and another pair of ligatures round the left part of the transverse colon, near the left flexure of the colon. Divide the transverse colon between the ligatures at each end; then cut the transverse colon away from the remains of the transverse meso-colon and its contents. Take the separated portions of the large intestine to the sink, remove the ligatures and wash out the cavity of each part with running water.

When the washing is completed divide the separated portion of the transverse colon into two equal parts. In the case of one of the two parts, carefully divide the longitudinal bands of muscle, in the intervals between the sacculi; then pull upon the extremities of the separated portion of the gut and note (1) that the intestine lengthens, (2) that to a great extent the sacculi disappears, and (3) that when the tension is removed the piece of intestine does not return to its former length. This simple experiment shows that it is the shortness of the longitudinal bands which causes the puckered condition of the wall of the large gut.

Now open the ascending colon, and the two parts of the transverse colon, and note that the mucous membrane of the large intestine is devoid both of plicæ circulares and of villi. Note, further, that in the ascending colon and that part of the transverse colon in which the longitudinal bands of muscle were not divided the mucous membrane is thrown into a number of transverse and oblique folds and ridges some of which correspond with the constrictions between the sacculi but others are independent of those constrictions, whilst in that part of the transverse colon in which the longitudinal muscle bands were stretched, after the longitudinal bands of muscle were divided, folds and ridges of the mucous membrane are practically absent. Obviously, therefore, in ordinary circumstances the mucous membrane of the large intestine is much more extensive than the other layers of the wall of that part of the gut. Indeed if the

mucous membrane is pulled out from the interior of the muscular tube it forms a tube about three times the length of the muscular tube. It is not as a rule possible to pull out a portion of the mucous tube from the interior of the muscular tube in formol-hardened dissecting-room subjects, but the experiment is easily made in the post-mortem room and the student should verify the above statements at the first favourable opportunity. Finally, hold the wall of the intestine to the light and note that whilst solitary lymph nodules are present there are no aggregated lymph nodules.

Structure of the Large Intestine.—The walls of the large intestine, like those of the small intestine, are formed by five layers or coats of tissue: (1) Serous, (2) Subserous, (3) Muscular, (4) Submucous, (5) Mucous.

The *Serous Coat* is complete only in the cases of the cæcum, which is surrounded with peritoneum, and the vermiform process, the transverse colon, and pelvic colon, which are provided with mesenteries. The ascending colon, the descending colon, the iliac colon and the rectum have no serous layer on their posterior aspects, and, in that respect, they correspond with the second and third parts of the duodenum. The anal canal is entirely devoid of serous covering.

The special peculiarity of the serous covering of the large intestine is the presence of numerous little fat-filled pouches of the membrane, called *appendices epiploicæ*, which project from the free margin of the gut, and which are present on all parts of the large intestine, except the vermiform process, the lower part of the rectum, and the anal canal.

The *Subserous Coat* is merely a thin stratum of areolar tissue which connects the serous layer with the muscular stratum.

The *Muscular Coat*, as in the case of the small intestine, consists of two strata, an external longitudinal stratum and an internal circular stratum.

The *longitudinal stratum* of muscle fibres forms a complete covering only in the vermiform process, the rectum, and the anal canal. In all other parts of the large intestine it is arranged in the form of three longitudinal bands whose positions have already been defined (see p. 337), but may here be re-stated—(1) One in relation to the attached surface (tænia mesocolica); (2) the second upon the anterior aspect (tænia libera); (3) and the third along the medial aspect of the gut, but, in the case of the transverse colon, the latter band is in relation to the inferior aspect of the tube (tænia omentalis). The bands commence at the

point where the vermiform process joins the cæcum, and they terminate in the complete stratum of longitudinal muscle of the rectum. The longitudinal muscle of the rectum forms a complete covering, but is not of uniform thickness; on the contrary it is much thicker on the anterior and posterior aspects of the rectum than it is on the sides. In the anal canal the longitudinal muscular stratum passes between the external and the internal sphincters, and terminates in the skin at the margin of the anal orifice. The circular stratum of muscle, as in the case of the small intestine, forms a complete and continuous covering throughout the whole length of the large intestine, but it is most distinct in the constrictions between the sacculi. At the lower end of the anal canal it is greatly increased in thickness to form the internal sphincter ani.

The *Mucous Membrane* of the large intestine, as already pointed out, is entirely devoid of the plicæ circulares and villi, which are such prominent features of the mucous membrane of the small intestine. Its internal surface, however, is not perfectly smooth, but is raised into numerous transverse and oblique ridges which can be obliterated by extension of the gut.

As in the case of the small intestine, the mucous membrane of the large intestine contains enormous numbers of tubular intestinal glands, whose orifices can be seen with the aid of a low-power lens. It contains no aggregated lymph nodules, but embedded in it are numerous solitary lymph nodules which project into the submucous layer.

Structure of the Vermiform Process.—The vermiform process differs in structure from the main part of the large intestine in some important respects. Its serous layer is practically complete and is not provided with *appendices epiploicæ.* Its longitudinal stratum of muscle forms a complete covering. Its mucous membrane is relatively thin and the intestinal glands are poorly developed, but the most striking differential feature is the enormous amount of lymphoid tissue in the submucous layer. The lymphoid tissue is deposited in the form of nodules, of relatively large but varying size, which are so closely packed together that they form a practically continuous layer between the circular muscle and the mucous membrane.

The remaining portions of the large intestine will be

considered in association with the dissection of the pelvis minor.

Dissection.—Place two ligatures round the descending colon, below the left colic flexure, and two more ligatures round the junction of the iliac with the pelvic colon; divide the bowel between each pair of ligatures and remove the descending and the iliac portions of the colon. Take the detached bowel to the sink, wash it thoroughly, open it, and note that, as in the other parts of the large intestine previously examined, the mucous membrane is devoid of villi and of plicæ circulares. After the separated parts of the intestine have been examined, clean the posterior wall of the abdomen in the regions from which they were removed and thus expose the structures which form their posterior relations. The structures behind the descending colon are the same as those behind the ascending colon (see p. 333), with the exception of the iliacus muscle, because the descending colon ends at the level of the crest of the ilium. Behind the iliac colon are the left iliacus muscle; the lateral cutaneous nerve of the thigh in front of the iliacus muscle; the left psoas major muscle; the femoral nerve in the angle between the iliacus and the psoas major; the spermatic vessels and the genito-femoral nerve in front of the psoas major; and the external iliac vessels at the inlet of the pelvis minor. After the structures mentioned have been displayed, clear away the remains of the transverse meso-colon from the front of the pancreas and proceed to the examination of the duodenum.

Duodenum.—It has already been noted that the duodenum is the first part of the small intestine; and it would have been examined, in proper sequence, immediately after the examination of the stomach, had it not been that a complete examination of it at that time would have interfered too much with the relations of other portions of the intestine which have now been removed.

The duodenum is from 25 to 30 cm. (ten to twelve inches) in length; it is the widest and the most fixed of the three parts of the small intestine, and its walls are thicker than those of the other two parts. It extends from the pylorus, which lies in the transpyloric plane half an inch to the right of the median plane, to the duodeno-jejunal flexure, which is situated at the left side of the second lumbar vertebra, slightly below the transpyloric plane and about an inch to the left of the median plane. Whilst passing from its commencement to its termination the duodenum describes a C-shaped curve, the concavity of the curve, which embraces the head of the pancreas, being directed upwards and to the left (Fig. 156).

For convenience of description the duodenum is divided into three parts—(1) superior, (2) descending, (3) inferior, and the

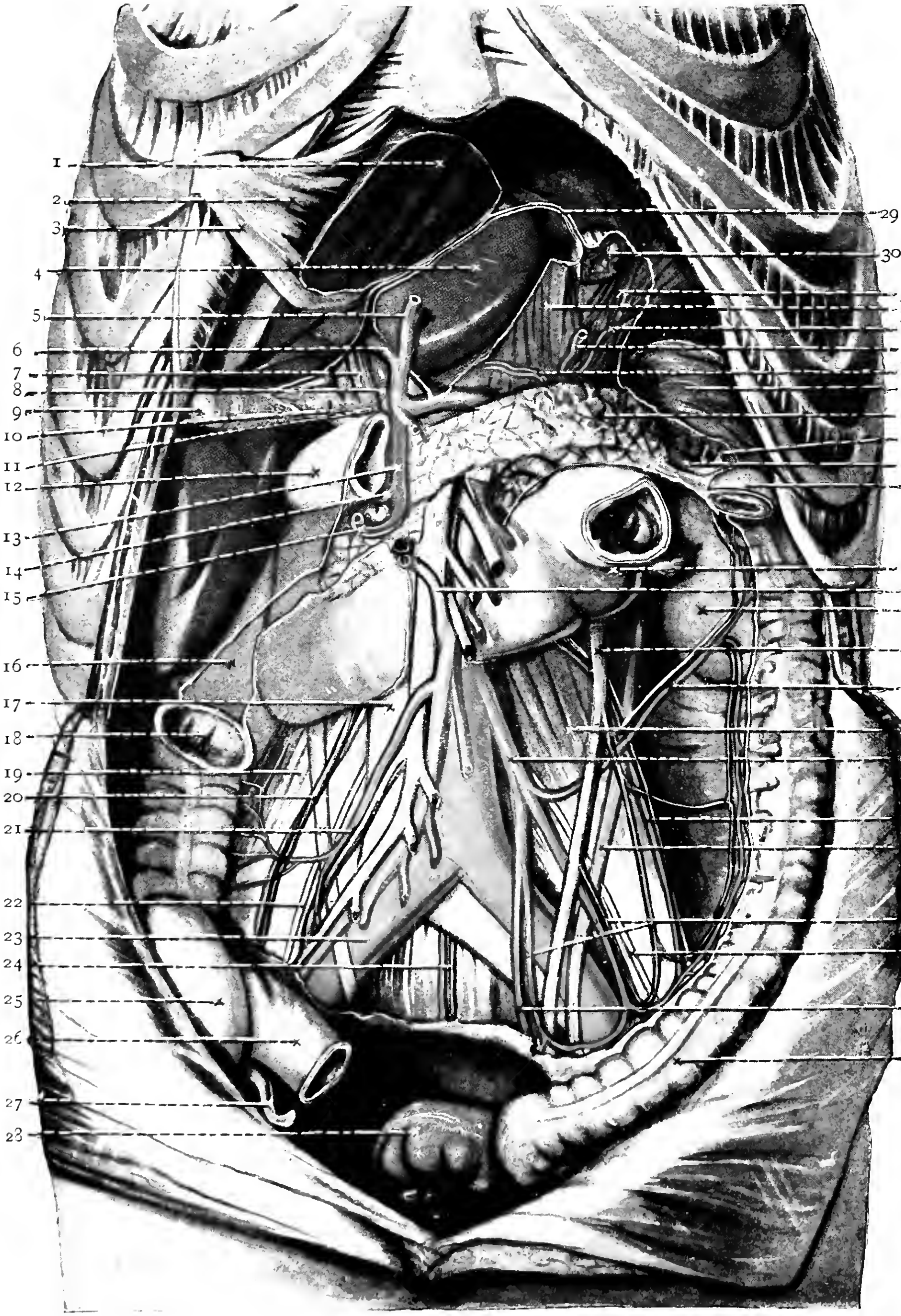
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FIG. 156.

PLATE XVI

FIG. 156.—Dissection of the Abdomen.

The left lobe of the liver, the stomach, the lesser omentum, the greater omentum, and the transverse colon have been removed.

The greater part of the posterior wall of the omental bursa has been dissected away, and the peritoneum and extra-peritoneal fat have been removed from the posterior wall of the lower part of the abdomen.

1. Cut surface of left lobe of liver.
2. Falciform ligament.
3. Ligamentum teres.
4. Caudate lobe.
5. Left hepatic artery.
6. Right hepatic artery.
7. Hepatic duct.
8. Portal vein.
9. Fundus of gall-bladder.
10. Cystic duct.
11. Bile duct.
12. Duodenum, superior part.
13. Gastro-duodenal artery.
14. Superior pancreatico-duodenal artery.
15. Right gastro-epiploic artery.
16. Duodenum, descending part.
17. Kidney.
18. Right flexure of the colon.
19. Psoas major muscle.
20. Spermatic vessel crossing ureter.
21. Common trunk of ileo-colic and right colic arteries.
22. Genito-femoral nerve.
23. Right common iliac artery.
24. Middle sacral vessels.
25. Cæcum.
26. Ileum.
27. Vermiform process.
28. Pelvic colon.
29. Cut edge of lesser omentum.
30. Œsophagus.
31. Left crus of diaphragm.
32. Right crus of diaphragm.
33. Left inferior phrenic artery.
34. Left gastric artery.
35. Right inferior phrenic artery.
36. Spleen.
37. Pancreas.
38. Left gastro-epiploic artery.
39. Splenic artery.
40. Left flexure of the colon.
41. Duodeno-jejunal flexure.
42. Middle colic artery.
43. Left kidney.
44. Inferior mesenteric vein.
45. Left colic artery.
46. Psoas major muscle.
47. Inferior mesenteric artery.
48. Spermatic vessels.
49. Ureter.
50. Sigmoid arteries.
51. Genito-femoral nerve.
52. Superior hæmorrhoidal artery.
53. Iliac colon.

inferior part is subdivided into horizontal and ascending sections. The greater portion of the superior part is surrounded by peritoneum which is continuous below with the greater omentum, and above with the lesser omentum, but its terminal portion is devoid of peritoneum behind and below. The descending part is covered by the peritoneum in front, and on the right side, except where it is crossed by the transverse colon. The horizontal portion of the inferior part is covered in front and below; and the ascending portion of the inferior part is covered in front and on the left side. The remaining surfaces of the descending and inferior parts of the duodenum are devoid of peritoneum, and they lie in relation either with other viscera, or with large blood-vessels, or with the posterior wall of the abdomen.

Pars Superior.—The superior part of the duodenum is two inches in length; it lies in the epigastric region, and for about an inch or more from the pylorus it is enveloped by the same two layers of peritoneum which invest the stomach; consequently, it enjoys a limited degree of movement. Its terminal portion is covered with the peritoneum only on its anterior and superior surfaces. Its position and relations are dependent upon the degree of distension of the stomach.

When the stomach is empty, and the pylorus is immediately to the right of the median plane below the left lobe of the liver, the superior part of the duodenum passes backwards and to the right and slightly upwards, along the inferior surface of the liver, to the neck of the gall-bladder. Its upper surface is in contact at first with the under surface of the left lobe of the liver, then it crosses the line of the umbilical fissure of the liver, and in the latter part of its course it is in relation with the lower surface of the quadrate lobe of the liver. When the stomach is distended the pylorus moves slightly to the right to the under surface of the quadrate lobe. Then the superior part of the duodenum is slightly shortened and it runs upwards and backwards beneath the quadrate lobe, and its terminal extremity is lodged in a depression at the left end of the porta hepatis. In both cases its termination bends suddenly downwards into the descending part. The relations of the superior part of the duodenum are as follows: *above* and *in front*, the visceral surface of the liver; *below*, the pancreas; *behind*, the vena cava, the bile-duct, the

gastro-duodenal artery, the portal vein, and the upper part of the neck of the pancreas.

Pars Descendens.—The descending part of the duodenum is from 7.5 to 10 cm. (three to four inches) in length. At its commencement it lies in the epigastric region, immediately below the liver, and it descends, along the medial face of the right lateral plane, into the umbilical region, to the level of the middle of the third lumbar vertebra, where it turns to the left and joins the inferior part. It is immovably fixed in its position; it is covered with peritoneum only on its anterior and right lateral surfaces, and it is crossed by the commencement of the transverse colon which does not possess a mesentery, and is therefore in direct contact with the descending part of the duodenum (Fig. 156). *Posteriorly*, it rests upon the right border of the inferior vena cava and presents a variable relation to the renal vessels and the anterior surface of the right kidney in the neighbourhood of the hilum. *To the right* is the right flexure of the colon; and *its left side* is in contact with the head of the pancreas, which is moulded upon the medial side of the descending part of the duodenum.

The bile-duct and the pancreatic duct open into the descending part of the duodenum a little below its middle, at the junction of its medial and posterior aspects.

Pars Inferior.—The first or horizontal portion of the inferior part of the duodenum crosses the posterior wall of the abdomen at the level of the third lumbar vertebra, its direction being from right to left and slightly upwards. To the right of the median plane it lies in the upper part of the umbilical region, but near its termination it rises above the subcostal plane into the epigastric region. Its anterior and inferior surfaces are covered with peritoneum. It lies behind the transverse colon; and it is crossed by the upper part of the root of the mesentery of the small intestine, containing the superior mesenteric artery and vein. Posteriorly, it rests against the right ureter, the right psoas major muscle, the right internal spermatic artery, the inferior vena cava, and the abdominal part of the aorta (Fig. 156). Its upper border is in relation with the head of the pancreas and the inferior pancreatico-duodenal artery; and its lower border is in relation with coils of the jejunum.

The second or ascending portion of the inferior part of the duodenum passes upwards from the level of the upper

part of the third lumbar vertebra to the duodeno-jejunal flexure. In front and on the left it is covered with peritoneum, and it is in relation with the upper part of the jejunum. To the right it is in relation, anteriorly, with the head of the pancreas and, posteriorly, with the aorta. Behind it lie the anterior border of the left psoas major muscle, and the left sympathetic trunk; and the left renal vein crosses behind it, unless the vein lies at a somewhat relatively higher level, behind the lower surface of the pancreas.

Dissection.—Cut through the peritoneum as it passes from the duodenum to the right kidney on the right, and from the duodenum to the posterior wall of the abdomen below and to the left; then turn the descending part of the duodenum medially, and the inferior part upwards, to examine the posterior relations noted above. The superior part of the duodenum and the attached portion of the pyloric end of the stomach can be turned to the right for the examination of the posterior relations of the superior part of the duodenum.

Suspensory Muscle of the Duodenum and the Root of the Mesentery.—The duodeno-jejunal flexure and the root of the mesentery are held in position and prevented from slipping downwards on the posterior wall of the abdomen by a band of involuntary muscular fibres which fixes them to the diaphragm. The band is called the suspensory muscle of the duodenum. It is attached above to the diaphragm, on the right side of the œsophageal aperture. From there it passes downwards, on the left side of the cœliac artery, to the duodeno-jejunal flexure, into which a large number of its fibres are inserted. The remaining fibres enter the mesentery and find attachment to the peritoneum. In the child the suspensory muscle is well marked and easily isolated, but in the adult it loses its distinctly muscular character and becomes more or less blended with neighbouring tissues.

Pancreas.—The pancreas is an elongated gland which stretches across the posterior wall of the abdomen behind the stomach. For the most part it is situated in the epigastric region, only a small portion of its left extremity being placed in the left hypochondriac region. Its form, as in the case of the other solid organs contained within the abdominal cavity, is greatly modified by the condition of the hollow viscera in its immediate vicinity, and its true shape can be ascertained only by fixing it *in situ* by injections of some

hardening reagent. It may be described as consisting of a *head*, a *neck*, a *body*, and a *tail*.

The *head of the pancreas* is the flattened portion of the gland which lies in front of the vertebral column and occupies the concavity of the duodenum. Posteriorly it is in relation with the inferior vena cava and to some extent also with the aorta. Its anterior surface is crossed by the transverse colon. As a rule its marginal lobules show a tendency to extend over the anterior surface of the descending and inferior parts of the duodenum so as to overlap the gut in the vicinity of its concavity. Certain other relations may be noticed in connection with the head of the pancreas, viz., (1) the bile-duct passes down behind it, in close relation to the second part of the duodenum; (2) the pyloric part of the stomach lies in front of it, above the transverse colon; (3) its lower part, the *uncinate process*, is prolonged to the left, along the upper border of the inferior part of the duodenum, behind the superior mesenteric vessels, and then upwards behind the neck of the pancreas; (4) the vena portæ is formed in front of the upturned part of the uncinate process and behind the neck of the pancreas.

The *neck of the pancreas* (Symington) is a narrow, constricted portion of gland-substance which springs from the anterior aspect of the head, nearer its upper than its lower margin. It constitutes the link of connection between the head and the body of the pancreas, and, as it proceeds to the left and forwards, it lies in front of the commencement of the vena portæ and of the termination of the superior mesenteric vein. Those vessels intervene between the neck and the anterior surface of the upper part of the uncinate process. The left part of the anterior surface of the neck is covered by the layer of peritoneum which forms the posterior wall of the omental bursa, and it is usually somewhat depressed by the pyloric end of the stomach, which rests upon it. The right part of the anterior surface is separated from the superior part of the duodenum by the gastro-duodenal artery.

The *body of the pancreas* extends from the anterior and left extremity of the neck, backwards and to the left, and slightly upwards, across the lower part of the left suprarenal gland, and the front of the left kidney, to the short *tail*, which lies in relation with the spleen. It presents *anterior*, *inferior*, and *posterior surfaces*, which are separated from each other by

superior, *anterior*, and *inferior borders*. The *anterior surface* looks forwards and upwards, and is covered by the peritoneum of the posterior wall of the omental bursa. In the greater part of its extent, the anterior surface supports the postero-inferior surface of the stomach, and is hollowed for its reception. Immediately adjoining the neck a smooth rounded prominence, *the tuber omentale of the pancreas*, projects upwards and forwards, from the junction of the anterior surface and the upper border of the pancreas, above and to the left of the lower part of the lesser curvature of the stomach. The tuber omentale abuts against the lesser omentum, which separates it from the omental tubercle of the liver.

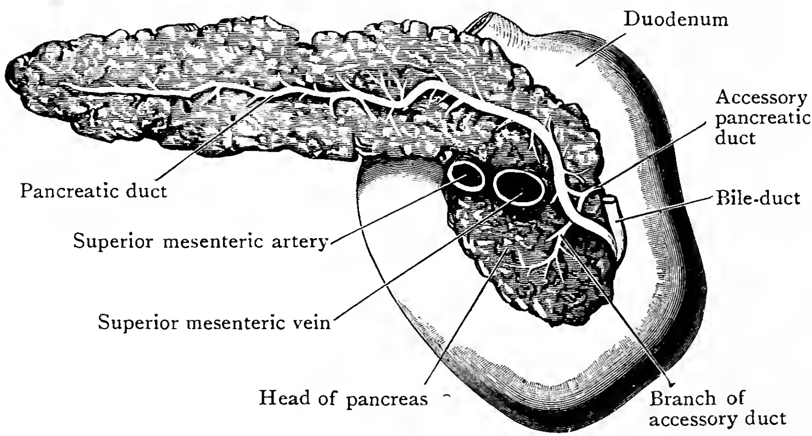

FIG. 157.—Dissection of the posterior surface of the Pancreas to show its Ducts. (Birmingham.)

The *inferior surface* of the body of the pancreas varies greatly in extent, in association with the varying degrees of intestinal pressure to which it is subjected from below. It looks downwards and rests upon the duodeno-jejunal flexure, coils of the small intestine, and the left part of the transverse colon close to the left flexure of the colon. It is completely covered with peritoneum which is continuous with the posterior layer of the transverse meso-colon.

The gastric pressure exerted on the pancreas from above, and the counter-pressure which is exerted by the intestine on the inferior surface of the organ from below, varying, as they do in the same subject, according to the condition of those hollow viscera, determine, in a great measure, the shape of the body of the pancreas. The body of the pancreas has the appearance of being wedged in between the two layers of the root of the transverse meso-colon.

The splenic artery pursues a wavy course along the superior border of the pancreas, whilst the transverse meso-colon is attached to its anterior border.

The *tail of the pancreas* abuts against the visceral aspect of the spleen, and it usually rests in a small depression on the lower and medial part of the gastric concavity of that organ (Fig. 169, p. 360).

Dissection.—**To display the posterior relations of the body and neck of the pancreas, raise the tail from the spleen; then, working from left to right, carefully separate the body and the neck from the structures which lie behind them.**

The *posterior surface* of the body of the pancreas lies in front of the middle portion of the left kidney; in front of the hilum of the kidney and the structures which pass through it; in front of the lower part of the left suprarenal gland; in front of the left crus of the diaphragm; and it joins the left and anterior end of the neck. The splenic vein runs behind its upper border, between it and the kidney and the left suprarenal gland, to reach the back of the neck, where it joins with the superior mesenteric vein to form the portal vein. The inferior mesenteric vein passes behind the posterior surface to join the splenic vein, and the left internal spermatic vein also ascends behind it to join the left renal vein, which issues from the hilum of the kidney and passes to the right, behind the posterior surface of the body of the pancreas, to join the inferior vena cava behind the head of the pancreas.

Ducts of the Pancreas.—The ducts of the pancreas are, as a rule, two in number—a main duct and an accessory duct. Both run within the gland substance.

The main *pancreatic duct* (*Wirsungi*) begins at the tail of the gland by the union of the small ducts issuing from the lobules in that region, and it proceeds towards the right. During its course it gains considerably in size, being joined by numerous small ducts which issue from the various groups of lobules. At the neck of the gland it bends downwards into the substance of the head. If the gland substance is carefully divided, little difficulty will be experienced in discovering the main duct. The extreme whiteness of its walls renders it conspicuous. Close to the duodenum the pancreatic duct comes in contact with the bile-duct, and, in company, both pierce the coats of the descending part of

the duodenum upon its posterior and medial aspect, and terminate in its wall in a dilatation, the *ampulla of Vater*, which opens into the cavity of the duodenum at the apex of a papilla called the *papilla duodeni.*

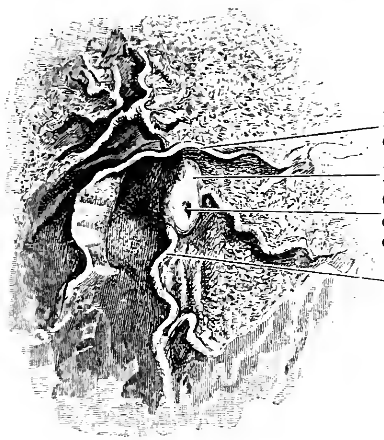

FIG. 158.—The Papilla Duodeni, situated at the upper end of the Plica Longitudinalis. (Birmingham.)

The *accessory duct* (*Santorini*) is small, and arises in the lower part of the head of the gland. It usually has an independent opening into the duodenum, above and anterior to the opening of the main duct. It may communicate with the main duct.

The dissector is now in a position to study the *biliary ducts* and the *portal vein.*

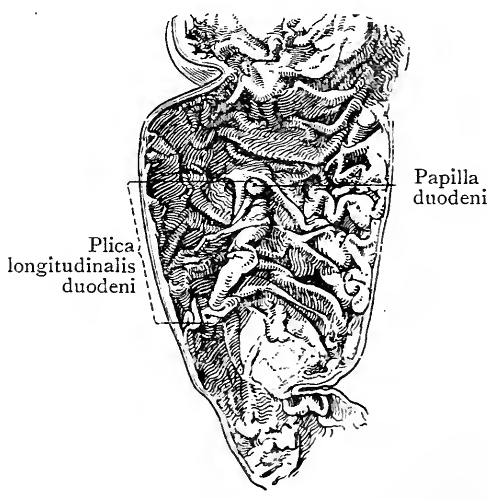

FIG. 159.—Pars Descendens Duodeni, opened from the right side. Showing the duodenal papilla at the upper end of the plica longitudinalis under a hood-like plica circularis.

Ductus Biliferi.—The ducts which carry the bile, secreted by the liver, from the liver and the gall-bladder to the duodenum are—(1) the right and left hepatic ducts, (2) the common hepatic duct, (3) the cystic duct, and (4) the bile-duct. Bile flows only in one direction through the hepatic ducts and the bile-duct, that is, towards the duodenum; but through the cystic duct it flows sometimes to and sometimes from the gall-bladder.

The *right* and *left hepatic ducts* issue from the corresponding lobes of the liver into the porta hepatis, and unite within it to form the *common hepatic duct.* The latter, which is about 25 mm. (one inch) in length, descends into the upper part of the lesser omentum, where it unites with the cystic duct (which has already been examined, p. 281) to form the bile-duct. As it descends, the common hepatic duct passes either anterior to or posterior to the right branch of the hepatic artery.

Ductus Choledochus (O.T. **Common Bile-Duct**).—The ductus choledochus is from 8 to 10 cm. (three and a half to four inches) long. In the first part of its course it lies in the right free border of the lesser omentum, to the right of the hepatic artery, and in front of the epiploic foramen, from which it is separated by the right border of the portal vein and the posterior layer of the lesser omentum. In the second part of its course it passes behind the first part of the duodenum, with the gastro-duodenal artery, close to the posterior or right end of the neck of the pancreas; then, entering on the third part of its course, it dips behind the right border of the head of the pancreas, and, coming into relation with the main duct of the pancreas, it accompanies that duct into the wall of the second part of the duodenum, where they both enter the ampulla of Vater. The ampulla opens into the cavity of the gut by a single orifice, which is situated on the duodenal papilla (Figs. 118, 159, 160).

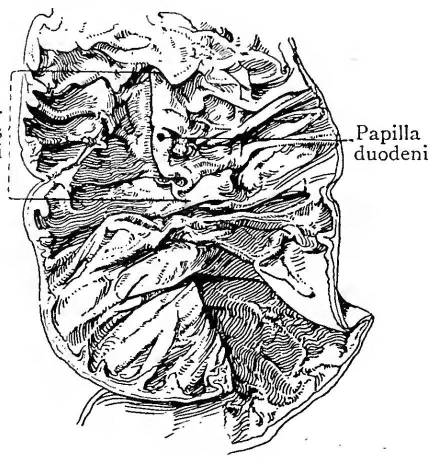

FIG. 160.—Pars Descendens Duodeni, opened from the right side. Showing the duodenal papilla at the middle of the plica longitudinalis.

Dissection.—**Make a vertical incision in the anterior wall of the second part of the duodenum, nearer its right than its left**

border. At the upper and lower ends of the vertical incision make short transverse incisions, and turn aside the flaps, so formed. Clean the interior of the duodenum with a sponge, and then examine the mucous membrane. Note that the mucous membrane of the descending part is thrown into numerous and large plicæ circulares, and that, as a rule, it is deeply stained by bile. Look for a longitudinal fold of the mucous membrane, the *plica longitudinalis*, which lies at the junction of the medial and posterior walls, nearer the lower than the upper end. It serves as a guide to the duodenal papilla, which frequently lies at its upper extremity, usually concealed by one of the largest of the plicæ circulares (Fig. 159). Pass a small probe through the

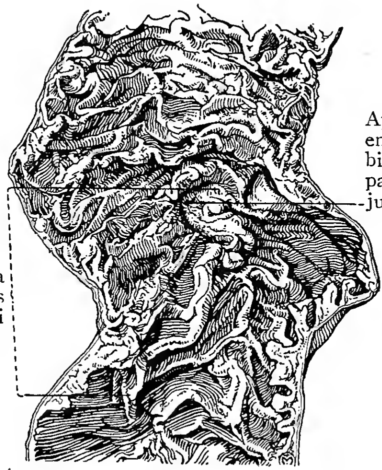

FIG. 161.—Pars Descendens of the Duodenum, opened from the right side. Showing the aperture for the passage of the bile and pancreatic juice on the upper part of the posterior face of the plica longitudinalis. There was no duodenal papilla.

opening on the apex of the papilla into the ampulla. Make an opening in the lower part of the bile-duct, and pass a small probe along the duct into the ampulla; perform the same operation on the main pancreatic duct; then cut down through the medial wall of the gut and open up the lumina of the ducts, the cavity of the ampulla of Vater, and its orifice of communication with the interior of the duodenum.

The dissector should note that whilst the duodenal papilla usually lies at the upper end of the plica longitudinalis (Figs. 158, 159) it may be situated on the middle of the plica (Fig. 160), and it may be absent. In the latter case the aperture through which the bile and the pancreatic juice enter the duodenum lies in a recess, at the side of the upper part of the plica longitudinalis (Fig. 161).

Vena Portæ (Portal Vein).—Blood is carried to the liver both by the hepatic artery and by the portal vein. The

hepatic artery, which carries arterial blood, has already been examined, p. 300. The portal vein, which carries the venous blood from the whole of the abdominal part of the alimentary canal, except the anal canal, and from the spleen, the pancreas, and the gall-bladder, must now be studied. It is

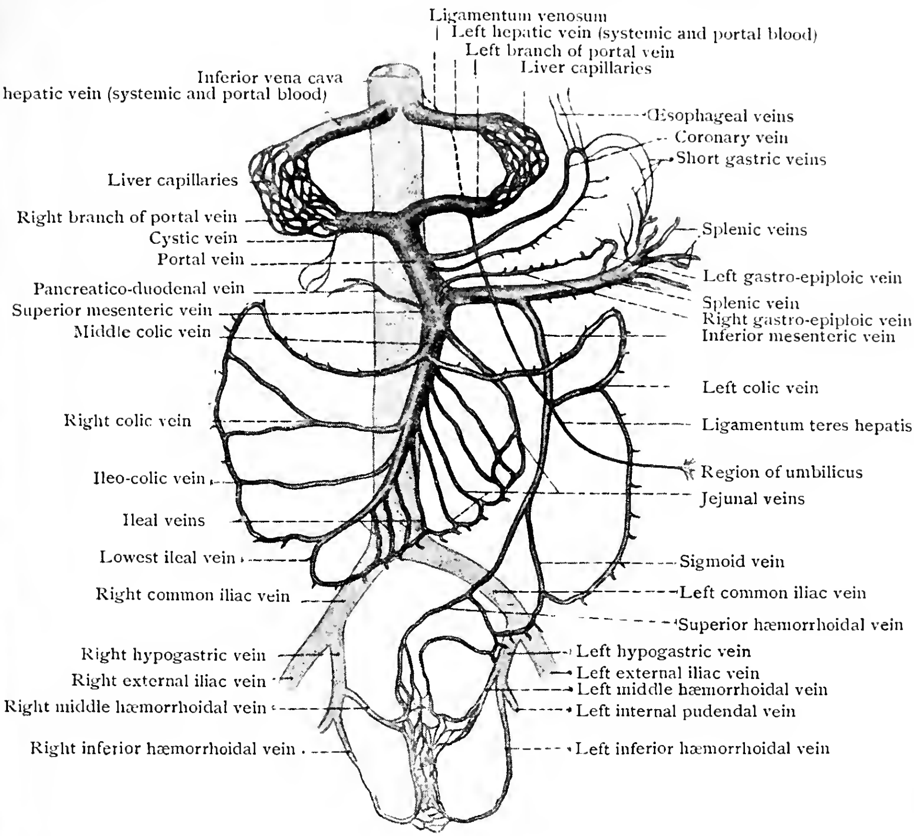

FIG. 162.—Schema of the Portal System of Veins and its connections with the Systemic System. It must be remembered that the systemic blood carried by the hepatic artery also enters the liver capillaries, therefore the hepatic veins contain both portal and systemic blood.

formed by the union of the superior mesenteric and splenic veins, behind the neck of the pancreas, between the neck and the upturned uncinate process of the head of the pancreas. It ascends, behind the first part of the duodenum and in front of the inferior vena cava, to the lower margin of the epiploic foramen, where it leaves the vena cava, enters the lesser omentum, and continues upwards, in front of the epiploic foramen and behind the bile-duct and the hepatic

artery (Fig. 156), to the right extremity of the porta hepatis; there, after enlarging slightly, it divides into a wide, short right branch, and a longer and narrower left branch. Its length is about 5 cm. (two inches), it is, therefore, relatively short, but it is a wide vessel and is capable of carrying a large stream of blood. In addition to its two main tributaries, viz., the superior mesenteric and the splenic veins, the vena portæ receives the coronary vein of the stomach and the right gastric vein. Occasionally the inferior mesenteric vein joins its commencement, instead of opening into the splenic vein. The right branch receives the cystic vein and then enters the right lobe of the liver. The left branch runs to the left along the porta, crosses the fossa for the umbilical vein, and enters the left lobe of the liver. As it crosses the umbilical fossa it is joined, anteriorly, by the ligamentum teres and some small para-umbilical veins, and, posteriorly, by the ligamentum venosum. The small para-umbilical veins, which join the left branch, run along the ligamentum teres of the liver, and communicate, at the umbilicus, with the superficial veins of the abdominal wall.

Vena Lienalis.—The splenic vein commences by the union of a number of tributaries which issue from the hilum on the gastric surface of the spleen. It runs backwards through the lieno-renal ligament, and then passes to the right, to its union with the superior mesenteric vein behind the neck of the pancreas. As it runs from left to right it lies behind the upper part of the posterior surface of the pancreas and in front of the left kidney, the left suprarenal gland, and the abdominal aorta, crossing the aorta between the origins of the cœliac and the superior mesenteric arteries. It conveys blood not only from the spleen, but also from the stomach and the pancreas. The blood from the stomach is conveyed to it by the left gastro-epiploic and the short gastric veins, which pass backwards in the gastro-splenic ligament and join its splenic tributaries; and as it passes along the pancreas it receives tributaries from that gland.

Dissection.—Cut through the œsophagus immediately below the diaphragm; detach the stomach from the diaphragm by severing the gastro-phrenic ligament, and from the spleen by cutting through the remains of the gastro-splenic ligament and dividing the short gastric arteries, the left gastro-epiploic artery, and the accompanying veins. Remove the separated portion of the stomach and examine its structure.

Structure of the Stomach.—The coats of the stomach are five in number, viz. :—

1. Peritoneal, or serous.
2. Subserous.
3. Muscular.
4. Submucous.
5. Mucous.

The *serous coat*, consisting of the peritoneal membrane, can be stripped off best by the fingers. The *subserous coat* is composed of a little areolar tissue which intervenes between the muscular and serous strata. The branches of the two vagi nerves can now be followed, as they spread out upon the two surfaces of the stomach.

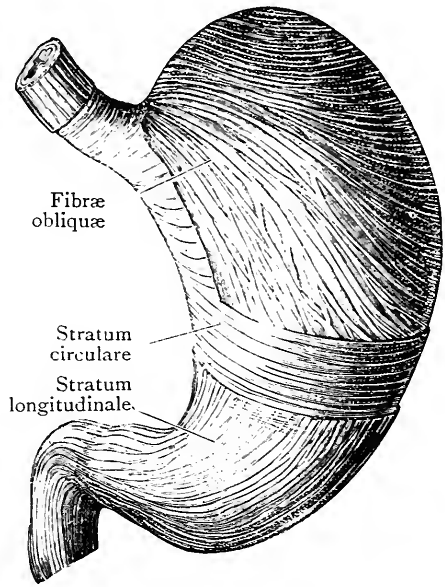

FIG. 163.—Dissection of the three layers of Muscular Fibres in the Wall of the Stomach.

The *muscular coat* of the stomach consists of involuntary muscle fibres which are arranged in three strata; an *external longitudinal stratum*, an *intermediate circular stratum*, and an *internal oblique stratum*. The external longitudinal stratum is continuous above with the longitudinal fibres of the œsophagus and below with the longitudinal fibres of the duodenum. It is best marked along the lesser curvature, and in the region of the pylorus, where it takes part in the formation of the pyloric sphincter; on the greater curvature, on the fundus, and on the surfaces of the stomach it is extremely thin. Nevertheless it is the only muscular stratum which forms a continuous and unbroken sheet. The intermediate circular stratum commences as a series of U-shaped loops, which only partially encircle the body of the stomach. At the upper part of the lesser curvature they are continuous with the superficial circular fibres of the œsophagus. Thence they extend over both surfaces of the body of the stomach but fail to reach the great curvature, and they are absent over

the fundus. Further to the right they form complete circles, and in the region of the pylorus, where they are greatly increased in number, they form the thick powerful sphincter of the pyloric orifice (Fig. 168). The oblique internal fibres are continuous with the deep circular fibres of the œsophagus. They are deficient along the lesser curvature and in the pyloric region. They are spread over the body of the stomach as scattered strands, but they completely ensheath the fundus where the proper circular stratum is deficient, and in that region they assume a circular arrangement.

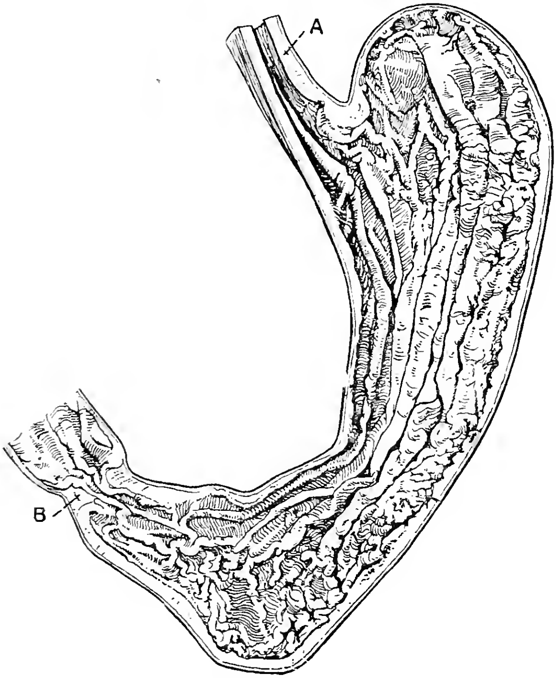

FIG. 164.—Posterior Wall of an Empty and Contracted Stomach. Showing the folds of the mucous membrane.

A, Œsophagus; B, Pylorus.

The *submucous coat* is composed of lax areolar tissue. It intervenes between the muscular and mucous coats, and binds them loosely to each other in such a manner that the mucous membrane can glide freely upon the internal surface of the muscular coat.

The *mucous coat* must be studied from the inside of the stomach. Open up the viscus by running the scissors along the lesser curvature. The gastric mucous membrane will then be seen to be thick, soft, and pulpy. In the dissecting-room the student cannot obtain a proper idea of its natural colour. In infancy it is rosy red, but as life advances it gradually becomes paler, and in old age it presents a brownish hue owing to the presence of pigment. When the mucous membrane is cleansed and examined with a pocket-lens, its

surface is observed to present a pitted appearance. Innumerable polygonal depressions are brought into view; they are larger and better marked near the pylorus than in the vicinity of the fundus. At the bottom of the depressions are the mouths of the minute tubular glands of the gastric mucous membrane (Fig. 165).

The mucous membrane has little elasticity, and, consequently, when the stomach contracts and becomes empty the membrane is thrown into projecting folds or rugæ which, for the most part, run in the longitudinal direction and

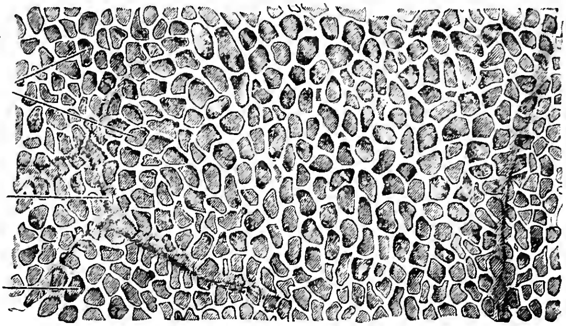

FIG. 165.—Mucous Membrane of the Stomach magnified 25 diameters.

occupy the cavity of the organ (Figs. 164, 166). As the stomach expands the folds open out, and they disappear when complete distension is attained.

> ***Dissection.***—**Extend the incision already made in the second part of the duodenum upwards into the first part, to within a short distance of the pyloric constriction, and examine the pyloric orifice and the pyloric canal.**

Pyloric Orifice and Pyloric Canal.—The extremity of the pyloric canal protrudes into the commencement of the duodenum, so that, when viewed from the duodenal side, it presents the appearance of a smooth, rounded knob, surrounded by a shallow furrow or fornix, and having a small puckered orifice, the *pyloric opening*, in its centre (Fig. 167). Its resemblance to the external orifice of the uterus is very striking. When the stomach has been properly hardened *in situ* the pyloric orifice is almost invariably found tightly closed. It is only on rare occasions that it is actually open. In such cases it is circular, and surrounded by a ring-like ledge which has been called the pyloric valve. During life the pyloric opening may be regarded as being always rigidly

closed, except during digestion, when it opens intermittently, and at irregular intervals, to allow material to be squirted from the stomach into the duodenum.

The muscular coat of the pyloric canal is modified to adapt it to its function. It is provided with a powerful sphincteric apparatus. Both the circular and longitudinal muscular fibres are present in greater mass than in any other part of the organ. The circular fibres are disposed in the form of a thick sphincteric muscular cylinder which surrounds the entire length of the pyloric canal. At the duodeno-

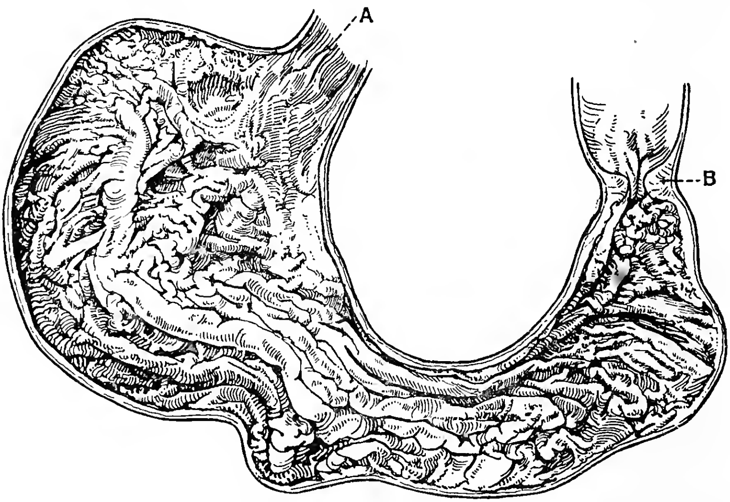

FIG. 166.—Anterior Wall of a Slightly Distended Stomach. Showing the folds of the mucous membrane.

A, Œsophagus; B, Pylorus.

pyloric constriction the margin of this cylinder becomes increased in thickness, forming thereby the strong muscular ring which encircles the pyloric orifice and constitutes the *pyloric sphincteric ring*. The knob-like appearance presented by the extremity of the pyloric region, when viewed from the interior of the duodenum, is produced by the presence of the muscular ring beneath the mucous membrane. The sphincteric cylinder which surrounds the pyloric canal varies much in its thickness in accordance with different degrees of contraction of the canal.

The longitudinal muscle fibres likewise form a thick layer on the superficial aspect of the sphincteric cylinder and ring. They are uniformly disposed around the pyloric canal, but

comparatively few of them pass superficially over the duodeno-pyloric constriction to become continuous with the corresponding fibres of the muscular coat of the duodenum. As they approach the duodenum the deeper longitudinal fibres of the pyloric canal leave the surface and penetrate the substance of the pyloric sphincteric ring. There can be little doubt that the arrangement forms an effective apparatus, antagonistic to the pyloric sphincteric ring, by means of which, when the sphincter relaxes, the pyloric orifice may be dilated. There is thus a constrictor and a dilatator of the pylorus.

In suitable specimens this arrangement of the muscle fibres may be seen by the naked eye when a longitudinal

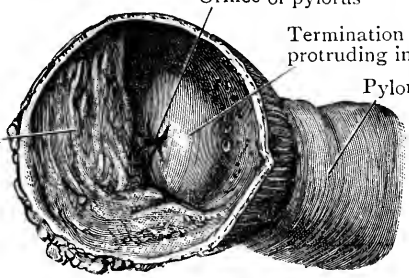

FIG. 167.—Small portion of the Pyloric part of the Stomach with part of the Duodenum attached.

section is made through the pyloric canal in the plane of the two curvatures of the stomach (Fig. 168).

> ***Dissection.*—Open the duodenum from end to end by an incision carried along its convex border; then clean it with a sponge.**

Structure of the Duodenum.—The structure of the duodenum is generally similar to that of other parts of the small intestine. That is, its wall is formed by five main coats or layers: (1) serous; (2) subserous; (3) muscular; (4) submucous; (5) mucous. The serous coat is complete only over the greater portion on the superior part (see p. 342). All the other parts are covered by peritoneum only on two faces—the descending part in front, except where it is crossed by the transverse colon, and on the right; the horizontal section of the inferior part in front and below, and the ascending section of the inferior part in front and

on the left; the subserous, muscular, and submucous layers have no special features of importance. There are, however, special features to be noted in association with the mucous layer. It is covered throughout by villi, but plicæ circulares are present only in the descending and inferior parts. There, however, they are very large and abundant. In the lower portion of the descending part a longitudinal fold, the plica longitudinalis duodeni, which has already been examined (p. 350), cuts across the line of the plicæ circulares. It terminates above at the papilla duodeni, through which the bile and pancreatic juice are poured into the duodenum

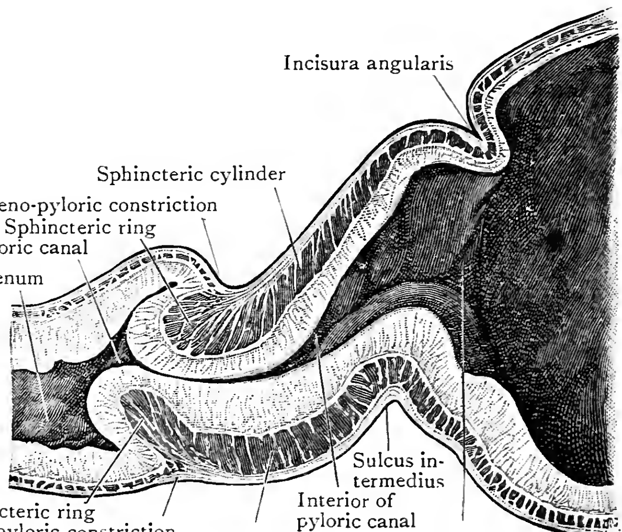

FIG. 168.—Pyloric Canal and Pyloric Antrum of the Stomach opened up by section in the plane of the two curvatures.

Opening on the surface of the mucous membrane are the orifices of numerous intestinal glands, and intermingled with them, especially in the pars superior, are the orifices of the special *duodenal glands*.

Dissection.—Take a segment of the wall of the first part of the duodenum and pin it down, with its mucous surface undermost, to the bottom of a cork-lined tray filled with water. Its coats may then be dissected. They are in all respects similar to those already examined in connection with the jejunum (p. 325). If the dissection is carried on until the deep surface of the submucous coat is exposed by the removal of the entire muscular coat, a view of the duodenal glands may be obtained. They appear as whitish specks, about the size of hemp-seed, in

the submucous tissue. They are most numerous close to the pylorus, and gradually disappear about two inches beyond it.

Lien (Spleen).—The spleen is a solid organ which lies deeply in the left part of the costal zone, and is altogether out of sight in the undisturbed condition of the viscera, but it is exposed when the stomach is removed. It lies very obliquely in the abdominal cavity, its upper end being much nearer the median plane and much further back than its lower end. Its long axis is directed from above downwards and laterally, and also to some extent forwards. For the most part it lies in the left hypochondrium, but its upper end extends medially beyond the left lateral plane, so that fully a third of the organ is situated in the epigastric region.

The spleen, when properly hardened *in situ*, has the shape of an irregular tetrahedron. Its four surfaces are the diaphragmatic, the gastric, the renal, and the colic. The *diaphragmatic surface*, which is the most extensive of the four, is convex. It looks backwards and laterally; it rests against the posterior part of the diaphragm, to the curvature of which it is adapted, and it is separated by the diaphragm from the lower parts of the left lung and pleura, and from the ninth, tenth, and eleventh ribs.

The three remaining surfaces, the gastric, the renal, and the colic, look towards the interior of the abdomen; they are all in close apposition with the adjacent viscera and, consequently, they are grouped together as the visceral surfaces. Of the three the gastric is the largest, the colic is usually the smallest, and all three are concave. They are separated from one another by three ridges which radiate from an inconspicuous prominence called the *intermediate angle*, which forms the apex of the tetrahedron (Fig. 169). One of the ridges, the *margo intermedius*, forms a salient border, which ascends from the intermediate angle to the superior angle, and separates the gastric from the renal surface. The superior angle is curved forwards on itself to some extent, and approaches close to the left suprarenal gland. A second and much shorter ridge passes backwards from the intermediate angle, and terminates at the posterior angle; it separates the renal surface from the colic surface. The third ridge, which is often rounded and indistinct, passes forwards from the intermediate angle to the anterior angle, and separates the gastric from the colic surface.

The *gastric surface* is the largest of the three visceral areas. It is deeply concave, and is moulded upon the fundus and the upper part of the posterior surface of the body of the stomach. Within its area, a short distance in front of the margo intermedius which separates it from the renal surface, there is a longitudinal cleft, the hilum, through which the vessels and nerves enter and leave the organ. The hilum is not uncommonly broken up into several segments. Behind the hilum, and immediately in front of the intermediate angle, there is a *pancreatic impression*

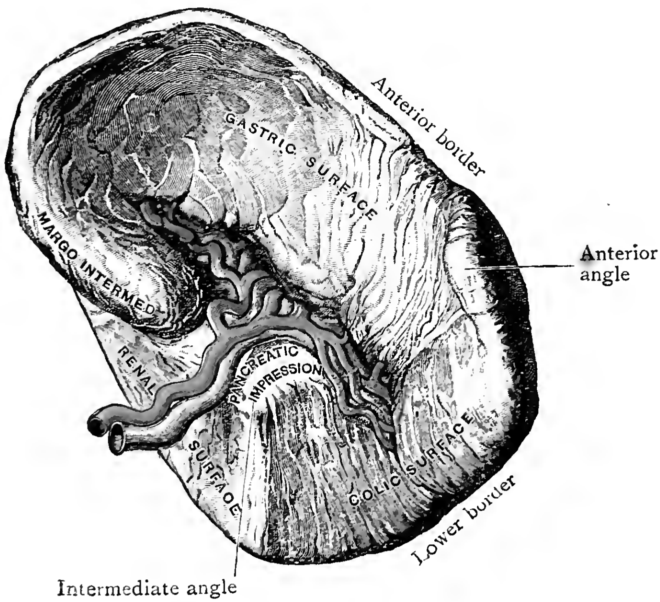

FIG. 169.—The Spleen (visceral aspect).

of very variable depth and extent, in which the tail of the pancreas rests.

The *renal surface* is also concave. It is of variable extent, and is applied to the lateral portion of the upper part of the anterior surface of the left kidney and to the adjacent part of the lateral border of the kidney. It is separated from the gastric surface by the margo intermedius, and from the diaphragmatic surface by the posterior border which extends from the superior to the posterior angle.

The *colic surface* is usually the smallest of the three visceral surfaces. It lies immediately above the inferior border, which separates it from the diaphragmatic surface, and between the

anterior, posterior, and intermediate angles. It is triangular in outline and concave in contour, and it rests upon the left flexure of the colon and upon the phrenico-colic ligament.

The *diaphragmatic surface* is the largest of the four surfaces. It is separated from the gastric surface by the notched anterior border, from the renal surface by the posterior border, and from the colic surface by the inferior border. It rests against the left part of the posterior portion of the diaphragm, by which it is separated from the lower parts of the left lung and pleura, and from the ninth, tenth, and eleventh ribs.

Of the several borders which separate the different surfaces from one another the anterior, the posterior, and the inferior are the most conspicuous. The *anterior border* lies between the diaphragmatic and the gastric surfaces. It extends from the superior to the anterior angle. It is crossed by two or more notches which can be felt, through the abdominal wall, when the spleen is enlarged, and which serve, therefore, for purposes of identification. The *posterior border* runs from the superior to the posterior angle, and separates the diaphragmatic from the renal surface. It is occasionally notched. The *inferior border*, which runs from the anterior to the posterior angle, separates the diaphragmatic from the colic surface.

Of the four angles the anterior is the most prominent and distinct. It lies at the junction of the anterior and the inferior borders, at the level of the eleventh rib in the mid-axillary line, and is the most anterior part of the spleen.

The spleen is entirely surrounded by peritoneum, and it is attached to two of the neighbouring viscera by folds of that membrane: (1) To the fundus and the vertical part of the body of the stomach by the gastro-splenic ligament, and (2) to the anterior surface of the left kidney by the lieno-renal ligament. Both the ligaments are attached to the spleen along the margins of its hilum (Fig. 135). It is also attached by the splenic artery to the coeliac artery, and by the splenic vein to the portal vein. It is supported in position not by its peritoneal and vascular attachments, but by the general intra-abdominal pressure, which is due to the tonic contraction of the abdominal muscles, and which compresses the adjacent viscera against it, and also by the phrenico-colic ligament, upon which its inferior border and [illegible] surface rest.

The form of the spleen varies very greatly with the varying degrees of distension of the hollow viscera which are related to its visceral aspect. There is good reason to believe that the tetrahedral form which is described above is associated with an empty or only slightly distended stomach and a well-distended intestine. When, however, the stomach is distended and the intestine is more or less empty, the basal surface partially or even entirely disappears, and then the spleen assumes a form similar to that of the segment of an orange (Shepherd).

Structure of the Spleen.—As the spleen will be required when the relations of the left kidney are studied, the dissector should obtain a sheep's spleen for the purpose of studying the structure of the organ. He will find that it is enveloped by two coats—(1) serous; (2) fibro-elastic. The *peritoneal investment* adheres so closely to the subjacent fibrous coat that it can be removed only with difficulty. With regard to the *fibro-elastic tunic* (tunica propria), it should be noted that processes, the *trabeculæ of the spleen*, proceed from its deep surface and dip into the substance of the organ. The trabeculæ constitute the supporting framework of the *gland-pulp*; therefore it will be found impossible to strip off the fibrous coat of the spleen without at the same time lacerating its surface. Make a section through the organ, and carry a portion of it to the tap. By squeezing it and allowing the water to run freely over it, the dissector may obtain a view of the trabecular framework.

***Dissection.*—The sympathetic plexuses in the upper part of the abdomen may now be studied with advantage. Throw the tail and body of the pancreas and the superior part of the duodenum over to the right. Next, turn to the left cœliac ganglion, which was displayed when the posterior wall of the omental bursa was removed; it lies between the left border of the cœliac artery and the medial border of the left suprarenal gland (see p. 298). From the medial border of the left cœliac ganglion trace sympathetic nerve fibres across the front of the aorta, round the root of the cœliac artery, to the opposite ganglion, which lies behind the inferior vena cava. To expose the right cœliac ganglion, therefore, it is necessary to displace to the right the portion of the inferior vena cava which lies behind the first part of the duodenum and to fix it out of the way with hooks or pins. Follow each cœliac ganglion upwards and backwards to its union with the greater splanchnic nerve of the same side, and follow the splanchnic nerve to the point where it passes into the abdomen by piercing the crus of the diaphragm of the corresponding side.**

Sympathetic Plexuses.—In connection with the sympathetic nervous system three large plexuses are formed in front of the vertebral column: they are the cardiac plexus, in the thorax; the cœliac plexus, in the upper part of the abdomen proper; and the hypogastric plexus, in the lower part of the abdomen proper.

The cœliac plexus (O.T. *solar plexus*), which is by far the

largest of the three, consists of the two cœliac (O.T. semilunar) ganglia and the numerous nerve bundles which connect the ganglia together.

It lies at the level of the lower part of the last thoracic and the upper part of the first lumbar vertebra, in front of the crura of the diaphragm and the uppermost part of the abdominal portion of the aorta, between the medial margins of the suprarenal glands, and around the cœliac artery. Numerous offshoots arise from it and pass either along the adjacent arteries, or to the suprarenal glands and the kidneys; the offsets constitute the secondary plexuses.

Ganglia Cœliaca (O.T. *Semilunar Ganglia*).—The cœliac ganglia are of irregular shape; they are frequently broken up into a number of connected segments, and they are so large that they are frequently mistaken by students for lymph glands. The upper extremity of each ganglion is joined by the great splanchnic nerve of the same side, whilst the lower part, which is often more or less detached, is connected with the lesser splanchnic nerve.

Plexus Gastricus Superior.—The superior gastric plexus springs from the front of the cœliac plexus. It accompanies the left gastric artery to the lesser curvature of the stomach and distributes twigs to both surfaces of that viscus.

Plexus Hepaticus.—The hepatic plexus also springs from the front of the central part of the cœliac plexus. It is joined by twigs from the left vagus nerve, and accompanies the hepatic artery, the portal vein and the bile-duct to the liver. At the lower margin of the lesser omentum, it gives off twigs which accompany the gastro-duodenal artery and its right gastro-epiploic branch; they constitute the *inferior gastric plexus*.

Plexus Lienalis.—The splenic plexus, like the superior gastric and the hepatic plexuses, springs from the median and anterior part of the cœliac plexus. It accompanies the splenic artery to the spleen, and is joined by twigs from the right vagus nerve. It gives offshoots along the various branches of the artery.

Plexus Renalis.—Each renal plexus consists of numerous nerves which spring chiefly from the lateral part of the corresponding cœliac ganglion. Some will be found, however, arising from the strands of the cœliac plexus and others from the aortic plexus. The *lowest* or *third splanchnic nerve*, when it is present, joins the renal plexus. Thus constituted, the filaments of the renal plexus run with the renal artery to the hilum of the kidney, and are distributed within the gland substance. Several twigs are given also to the spermatic plexus. A few scattered ganglia are usually found in connection with the renal plexus.

Plexus Suprarenalis.—The dissector will be struck with the large number of nerves which supply the suprarenal glands. They are derived chiefly from the cœliac ganglion of the same side, but many come from the strands of the cœliac plexus. Each suprarenal plexus is directly continuous below with the renal plexus, and it is connected above with the phrenic plexus. The lowest splanchnic nerve usually contributes a

branch to the suprarenal plexus, and the point at which it joins is marked by a small ganglion.

Plexus Phrenicus.—The filaments composing each phrenic plexus take origin from the upper part of the cœliac ganglion of the same side, and are distributed with the inferior phrenic artery to the inferior surface of the diaphragm, but they do not follow rigorously the branches of that vessel. At first they lie subjacent to the peritoneum, but soon they penetrate between the fleshy fasciculi and establish communications with the phrenic nerve. On the right side a small ganglion is formed on the inferior surface of the diaphragm at the point of junction between the phrenic plexus and the phrenic nerve. In addition to its diaphragmatic branches the phrenic plexus contributes filaments to the suprarenal plexus, and, on the right side, to the hepatic plexus.

Plexus Mesentericus Superior.—The superior mesenteric plexus springs from the lower part of the central portion of the cœliac plexus and descends, with the superior mesenteric artery, in the root of the mesentery of the small intestine. It sends offsets along the branches of the artery.

Plexus Aorticus Abdominalis.—The abdominal aortic plexus is formed mainly by branches derived from the ganglia of the abdominal parts of the sympathetic trunks, but it is connected, above, with the cœliac and superior mesenteric plexuses, and, below, branches which issue from it are prolonged downwards across the fronts of the common iliac arteries into the hypogastric plexus.

Plexus Spermaticus.—Each spermatic plexus receives filaments from the aortic plexus and from the renal plexus of the same side. It accompanies the corresponding internal spermatic artery and gives branches to the ureter as well as to the testis. In the female the corresponding plexus is called the *ovarian plexus* and accompanies the ovarian vessels.

Plexus Mesentericus Inferior.—The inferior mesenteric plexus springs from the aortic plexus, and at its commencement it contains a ganglion. It accompanies the inferior mesenteric artery and gives secondary offshoots along the branches of the artery.

***Dissection.*—Removal of the Spleen, Pancreas, and Duodenum.—The dissector should now proceed to the removal of the spleen, the pancreas, and the duodenum, which should be kept together and preserved, so that they can be replaced in position when the relations of the kidneys are being studied.**

Cut through—(1) the splenic artery, about 18 mm. (three-quarters of an inch) from its origin from the cœliac trunk; (2) the portal vein, about 25 mm. (one inch) above the union of the superior mesenteric and splenic veins; (3) the superior mesenteric artery, 12.5 mm. (half an inch) below its origin from the aorta; (4) the gastro-duodenal branch of the hepatic artery. Fix the splenic vein to the posterior surface of the pancreas with a few stitches. Pull the spleen over towards the right side and cut through the left layer of the lieno-renal ligament, which is still in position; then remove the spleen, the pancreas, and the duodenum from the abdomen.

Removal of the Liver.—The general position and connections of the liver have been considered, and the left lobe has been detached and laid aside (see p. 281). The right lobe must now be separated from the parts of which it is connected. Strip the peritoneum from the anterior surface of the inferior vena cava, from the point where it was exposed by the removal of the superior part of the duodenum to the point where it disappears into

the fossa venæ cavæ on the posterior surface of the liver. Raise the liver as much as possible, and, to the right of the inferior vena cava, cut through the layer of the peritoneum which is reflected from the lower part of the posterior surface of the liver to the diaphragm. That layer is the *lower layer of the coronary ligament*. At the base of the liver the lower layer of the coronary ligament becomes continuous with the right triangular ligament, which must also be divided. After the right triangular ligament is divided, pull the liver downwards as far as possible, and cut through the falciform ligament, which connects the anterior and superior surfaces of the liver to the anterior abdominal wall and to the diaphragm. Divide that ligament from before backwards, and note, as its posterior extremity is approached, that its right lateral layer becomes continuous with the *upper layer of the coronary ligament*, which passes from the posterior border of the upper surface of the liver to the diaphragm. Divide that layer from right to left, and be careful not to injure the upper part of the abdominal portion of the inferior vena cava, which lies immediately behind it, a little to the right of the line of attachment of the falciform ligament. Now, with the right hand, pull the right lobe of the liver forwards and to the left, detaching its posterior surface from the diaphragm with the fingers of the left hand, until the right border of the fossa for the inferior vena cava is reached ; then separate the vena cava from the fossa, with the fingers, from below upwards, until the large hepatic veins are reached as they pass out of the upper part of the posterior surface of the liver into the anterior wall of the inferior vena cava, immediately below the diaphragm. Divide those veins carefully with the knife and remove the right lobe of the liver from the abdomen.

After the right lobe of the liver has been removed from the abdomen, attach the left lobe to it with long pins, and study the various surfaces and parts of the gland with the utmost care.

The Surfaces of the Liver.—The anterior surface, and the base or right lateral surface, are smooth, convex, and covered with peritoneum. They are separated from each other by a rounded and indistinct border.

The Base is in relation with the right part of the diaphragm, from the level of the seventh to the level of the eleventh rib, in the mid-axillary line ; and it is separated by the diaphragm from the lower part of the right pleural sac and right lung.

The Anterior Surface is in relation with the anterior part of the diaphragm, on each side of the sub-costal angle, and, opposite the sub-costal angle, with the posterior surfaces of the sheaths of the recti muscles ; and the lower border of the falciform ligament is attached to it nearer to its left than to its right extremity.

The Superior Surface is smooth also and it is covered with peritoneum. On the right and on the left, where it fits into the corresponding cupolæ of the diaphragm, and is separated

by the diaphragm from the lungs and pleural sacs, it is convex, and more convex on the right side than on the left. In the intermediate area, where the diaphragm separates it from the pericardium and the heart, it is slightly concave, and running antero-posteriorly across the depressed area is the line of attachment of the falciform ligament, which separates the upper surface of the right lobe from the upper surface of the left lobe. The line of attachment of the falciform ligament to the upper surface terminates, posteriorly,

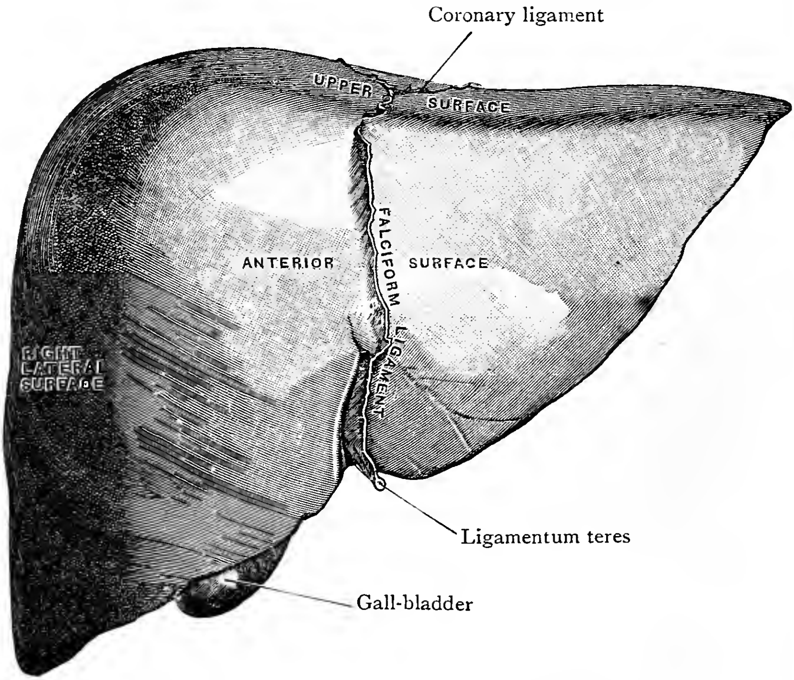

FIG. 170.—Anterior Surface of the Liver.

at the upper end of the fossa for the ductus venosus, and from that point the line of attachment of the left triangular ligament extends to the left, on the posterior part of the upper surface of the left lobe. A short distance to the right of the posterior end of the line of attachment of the falciform ligament, the posterior border of the upper surface is notched by the upper end of the fossa for the inferior vena cava. The portion of the posterior border of the upper surface which lies between the upper ends of the fossa for the ductus venosus and the fossa for the inferior vena cava is the upper end of the caudate lobe.

The inferior and *posterior surfaces* are each divided into segments by a right and a left pair of fossæ, which run parallel with the sagittal plane. The pair of sagittal fossæ, which separate the lower and the posterior surfaces into right and left lobes, are the *fossa for the umbilical vein*, on the inferior surface, and the *fossa for the ductus venosus*, on the posterior surface. The pair of sagittal fossæ, which segment the lower and posterior surfaces of the right lobe, are the *fossa for the gall-bladder* on the lower surface, and the *fossa for the inferior vena cava*, on the posterior surface.

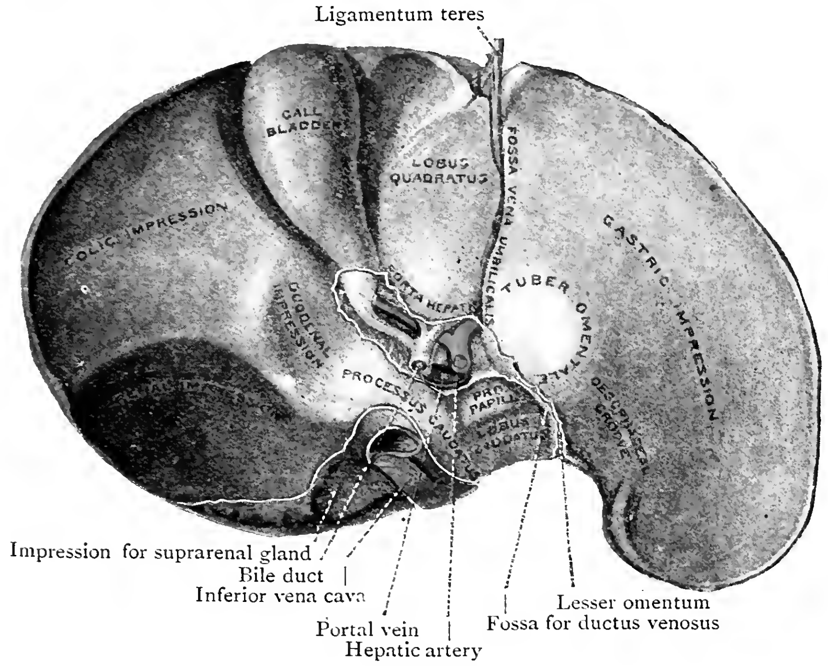

FIG. 171.—The Inferior or Visceral Surface of the Liver.

The Inferior or Visceral Surface of the Liver looks downwards, backwards and to the left, and rests partly upon viscera situated at a lower level in the abdomen and partly upon the front of the lesser omentum. It is separated into a larger right and a smaller left segment or lobe by the fossa for the umbilical vein. On the inferior surface of the right lobe, close to its posterior border and at its left extremity, is the *porta hepatis* or hilum of the liver, through which the hepatic artery and the portal vein pass into the liver, and the hepatic ducts and the lymph vessels pass out. It connects the posterior part of the

fossa for the umbilical vein with the posterior part of the fossa for the gall-bladder. The portion of the right lobe which lies in front of the porta, and between the fossa for the gall-bladder on the right and the fossa for the umbilical vein on the left, is the *quadrate lobe*, which frequently bears impressions made by the pylorus and the first part of the duodenum. Behind the porta hepatis, and between the lower ends of the fossa for the ductus venosus and the fossa for the inferior vena cava, is the lower end of the caudate lobe, which is usually divided, by a shallow sulcus, into a nodular left or *papillary process*, which projects downwards into the cavity of the omental bursa, and a right, band-like *caudate process*, which connects the lower end of the caudate lobe with the main part of the inferior surface of the right lobe. The remainder of the inferior surface of the right lobe is marked by three shallow impressions: (1) at the right extremity of the porta hepatis is an antero-posterior sulcus, the *duodenal impression*, for the second part of the duodenum; (2) to the right of the fossa for the gall-bladder is the *colic impression*, for the right flexure of the colon; (3) behind the colic impression is the *renal impression*, for the upper part of the anterior surface of the right kidney. Occasionally a fourth impression exists behind the duodenal impression; it is the *suprarenal impression*, which is always present on the posterior surface and may extend on to the inferior surface.

The inferior surface of the left lobe is marked by an elevation, the *tuber omentale*, and a depression, the *gastric impression*. The tuber omentale adjoins the left extremity of the porta hepatis and, when the liver is in position, it rests against the lesser omentum, immediately above the lesser curvature of the stomach. The gastric impression occupies the remainder of the lower surface of the left lobe lying in front and to the left of the tuber omentale.

The Posterior Surface of the Liver (Figs. 172 and 173).—The posterior surface is moulded upon the front of the vertebral column, from which it is separated by the diaphragm and the lower part of the descending thoracic aorta. It presents, therefore, a deep hollow corresponding to the bodies of the vertebræ and the structures in front of them. Immediately to the left of the fossa of the ductus venosus there is a smooth notch or groove, the *œsophageal impression*, which leads downwards into the gastric impression on the under

surface of the left lobe. The groove lies anterior to the œsophagus. To the left of the œsophageal groove the posterior surface of the left lobe merges into a sharp margin which separates the superior from the inferior surface.

It has been pointed out that the œsophageal groove in the liver is usually occupied by the prominent anterior margin of the œsophageal opening of the diaphragm, which, in the first instance, must be regarded as being responsible for the depression (Birmingham).

On the posterior surface of the right lobe there may be recognised—(1) the lobus caudatus (O.T. lobus Spigelii);

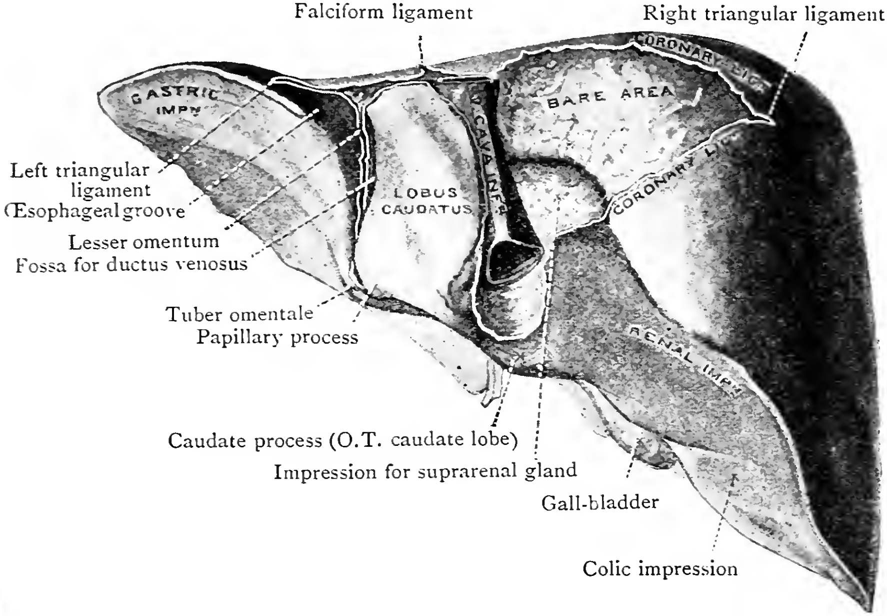

FIG. 172.—Posterior Surface of the Liver.

(2) the fossa for the inferior vena cava; and (3) an extensive "bare area" devoid of peritoneum.

The *lobus caudatus* (O.T. *lobus Spigelii*) is the portion of liver substance which lies between the fossa of the ductus venosus and the fossa of the inferior vena cava. Its lower end appears on the inferior surface of the liver immediately behind the porta hepatis. It is divided into the papillary process, on the left, and the caudate process, on the right (Fig. 172). The caudate lobe forms the bottom of the vertebral hollow, and is separated from the bodies of the tenth, eleventh, and twelfth thoracic vertebræ by the diaphragm and the lower part of the descending thoracic aorta.

Fossa Venæ Cavæ.—The *fossa for the inferior vena cava* is a deep groove placed on the right side of the caudate lobe. It ascends almost perpendicularly, and sometimes it is converted into a tunnel by a bridge of liver substance which passes behind the vein from the one side to the other. In its anterior wall the orifices of the divided hepatic veins will be seen.

The *bare area* of the posterior surface of the liver is triangular in form, and lies to the right of the fossa for the

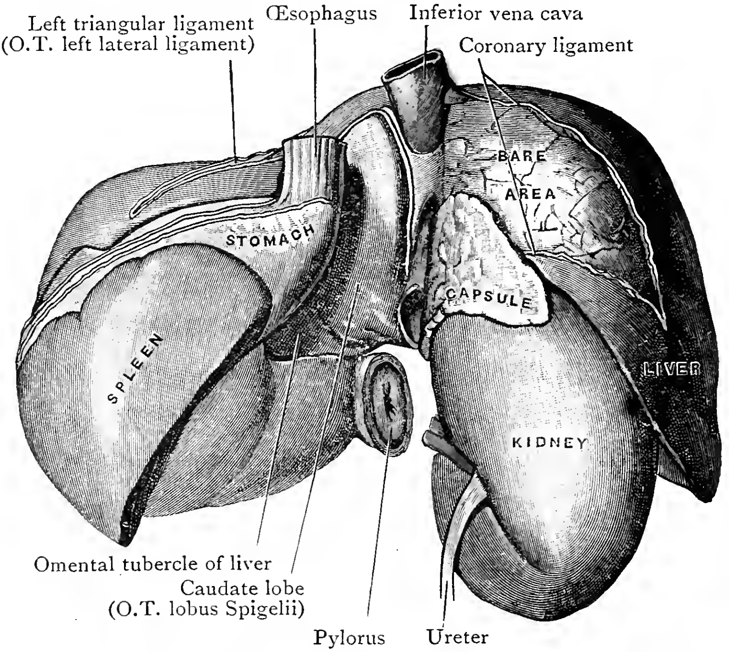

FIG. 173.—Liver, Right Kidney, Spleen, and Stomach, as seen from behind. Drawing made from a model prepared by the reconstruction method.

vena cava. It forms the greater part of the posterior surface of the right lobe, and is bounded above and below by the lines of reflection of the coronary ligament. For the most part it is convex, and it is connected with the diaphragm by loose areolar tissue, and some minute veins which unite the portal vessels of the liver with the systemic vessels of the diaphragm; but close to the lower end of the fossa for the vena cava there is a well marked depression, the *suprarenal impression*, which lodges the upper part of the right suprarenal gland.

Porta Hepatis (O.T. Transverse Fissure).—The porta hepatis, or hilum of the liver, is the cleft on the posterior part

of the lower surface of the right lobe through which the vessels and ducts enter and leave the liver. It lies near the posterior border of the lower surface, between the lower end of the caudate lobe posteriorly and the quadrate lobe anteriorly. It extends, transversely, from the upper and posterior end of the fossa for the gall-bladder, on the right, to the upper and posterior end of the fossa for the umbilical vein, on the left.

In the upper part of the lesser omentum, immediately below the porta, the bile-duct, the hepatic artery, and the portal vein are in close relation to each other, the artery lying to the left, the duct to the right, and the portal vein behind and between them. The branches of the three structures enter the porta in the same relative positions, and, as they pass into it, they become enclosed in a sheath of the fibrous capsule of the liver (O.T. Glisson's capsule). Trace them for a short distance into the substance of the liver and note that the portal vein branches like an artery, and wherever it divides, there also will the hepatic artery and hepatic duct be found to divide. The branches of the three structures, therefore, traverse the liver substance in company, and the fibrous capsule is prolonged into the liver with them, and follows them in their ramifications. The student is now in a position to understand the meaning of the term "*portal canal.*" It is employed to denote a channel in the liver substance, lined by a prolongation of the fibrous capsule, and holding in its interior a branch of the portal vein, a branch of the hepatic artery, and a branch of the hepatic duct.

Vessels of the Liver.—Blood enters the liver—(1) by the *hepatic artery*, (2) by the *portal vein*; whilst it passes away from the liver by the *hepatic veins*.

The *hepatic artery* is a branch of the cœliac artery. It carries arterial blood for the nourishment of the liver substance and divides into two branches which enter the liver at the extremities of the porta hepatis (p. 300).

The *portal vein* carries venous blood which it has gathered from the spleen, pancreas, and gall-bladder, and from the entire length of the abdominal portion of the alimentary canal (with the exception of the anal canal of the rectum). It reaches the inferior surface of the liver at the right extremity of the porta hepatis, where it divides into its two terminal branches. The terminal part of the portal vein, just before

it divides, is slightly expanded, forming the *sinus of the portal vein.* The *right branch* is a short wide vessel which immediately sinks into the right lobe of the liver; the *left branch*, much longer and considerably smaller, extends to the left along the bottom of the porta hepatis, and at the left extremity of that furrow it crosses the fossa for the umbilical vein and enters the left lobe of the liver. As it crosses the fossa for the umbilical vein the left branch of the portal vein is joined in front by the ligamentum teres, whilst the ligamentum venosum is attached to it behind.

The *hepatic veins*, which lead the blood out of the liver, have an arrangement altogether different from the vessels which enter at the porta hepatis. They converge towards the fossa for the vena cava, on the posterior surface of the liver, and cannot be said to have any course outside the liver, as they open at once into the vena cava inferior. Their gaping mouths will be found at the upper end of the fossa for the vena cava. Trace the hepatic veins for a short distance into the substance of the gland. They are remarkable for the tenuity of their walls, and also for the very small quantity of areolar tissue which separates them from the hepatic substance; indeed, the areolar tissue is so scarce around the large veins that it is hardly appreciable to the naked eye; it is entirely absent from the smaller veins, and their walls rest directly against the hepatic lobules.

A section should now be made through the liver substance and the cut surface examined. The portal veins can be readily distinguished from the hepatic veins. The following are the points of difference:—

Portal Veins.	Hepatic Veins.
1. Are always accompanied by a branch of the duct and a branch of the hepatic artery.	1. Are solitary and not accompanied by any other vessel.
2. Mouths usually collapsed.	2. Mouths usually open and gaping.
3. Walls thicker.	3. Walls exceedingly thin.
4. Walls separated from the liver substance by the fibrous capsule.	4. Walls apparently in direct apposition with the liver substance.

Structure of the Liver.—Very little of the structure of the liver can be learned in the dissecting-room. It is completely enveloped by a fibrous capsule (O.T. Glisson's). This is thick where the peritoneum is absent, but very thin where that

membrane is spread over the gland. The liver substance presents a mottled appearance, and when torn or ruptured the surface exhibits a granular aspect. The minute particles which give rise to this appearance are the hepatic lobules. In the human liver these are not completely separated from each other.

Glandulæ Suprarenales (O.T. **Suprarenal Bodies or Capsules**).—The suprarenal glands are two small, flattened bodies, which are placed upon the upper ends of the kidneys. Each suprarenal body surmounts the corresponding kidney after the fashion of a helmet, and is prolonged downwards for a short distance upon its anterior surface and its medial border. The suprarenal glands lie in the epigastric region, and rest posteriorly upon the diaphragm.

The Right Suprarenal Gland is, as a rule, triangular in form, and rests, by its base, upon the anterior and medial aspect of the upper end of the right kidney. It is placed between the posterior surface of the right lobe of the liver and the adjacent portion of the diaphragm at the side of the vertebral column.

The *anterior surface*, which looks laterally as well as forwards, is moulded into two areas by the pressure of the inferior vena cava and the liver—(1) The medial area is a narrow vertical strip which lies behind the inferior vena cava; (2) the lateral area is adapted to the posterior and inferior surfaces of the liver. Only a small and variable part of the lower portion of the anterior surface of the right suprarenal gland is covered with peritoneum. On the upper part of the impression for the vena cava, not far from the apex of the gland, a short fissure, termed the *hilum*, may be observed. From it issues a short wide suprarenal vein which immediately enters the inferior vena cava. The *posterior surface* of the right suprarenal gland is divided by a salient, curved ridge into an upper, flat part, which is applied to the diaphragm, and a concave, lower part, sometimes called the base; the concavity is occupied by fat which separates the gland from the kidney.

The Left Suprarenal Gland is semilunar in form, and, as a rule, is slightly larger than the right. Its position on the kidney is also somewhat different. It is usually placed on the medial border of the kidney above the hilum, but it may extend to the upper end.

The *anterior surface* presents, not far from its lower end, a very obvious *hilum* with a large emerging vein. The greater part of this surface is separated from the postero-inferior surface of the stomach by the posterior wall and the cavity of the omental bursa, and it forms a portion of the stomach bed. The lower portion of the anterior surface is covered by the pancreas and crossed by the splenic vessels, and is not in relation to the peritoneum. Occasionally the spleen extends so far medially that it lies in relation to the upper part of the anterior surface of the left suprarenal gland (see Fig. 155, p. 334), but that condition is uncommon. The *posterior surface* is subdivided into two areas by a curved ridge, as on the right side. The upper area is flat, and lies against the left crus of the diaphragm; the lower area is hollowed out and is in relation to the kidney, a considerable amount of fat intervening.

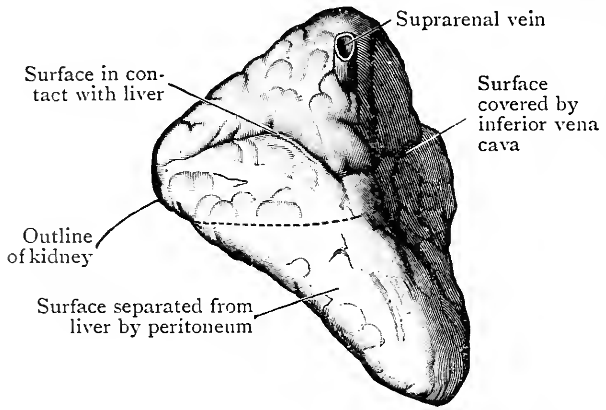

FIG. 174.—Anterior Surface of Right Suprarenal Gland.

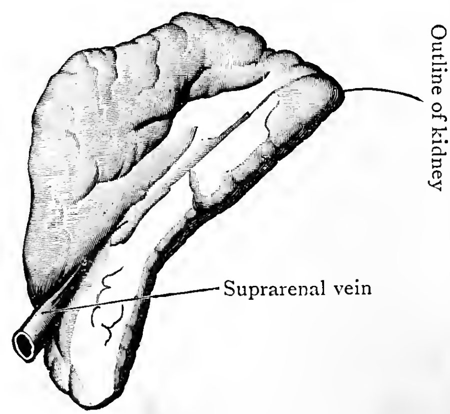

FIG. 175.—Anterior Surface of Left Suprarenal Gland.

The dissectors have already observed the abundant nerve supply to the suprarenal glands from the cœliac plexus. Their blood supply is equally rich. No fewer than three arteries enter the substance of each, viz.—the *superior*, *middle*, and *inferior suprarenal arteries*.

When a section is made through the suprarenal gland it is seen to consist of an external, firm portion, termed the *cortex*, and of a soft, pulpy, dark-coloured internal substance, called the *medullary part*.

Renes.—The kidneys are situated behind the peritoneum, against the posterior wall of the abdomen—one on each side of the vertebral column. Each is enveloped by a capsule of loose areolar tissue, the meshes of which are loaded with soft, pliable fat. Take the fat away, and be careful to preserve the *suprarenal gland*, which lies upon the upper end of each kidney.

Each *kidney* is placed opposite the bodies of the last thoracic and the upper three lumbar vertebræ. It extends from the upper border of the last thoracic vertebra to the middle of the body of the third lumbar vertebra; and it lies obliquely—its upper end being somewhat nearer the median plane than its lower end. The kidneys lie for the most part in the hypochondriac and epigastric regions. As a rule the left kidney is confined entirely to those districts; but the right kidney, which is generally slightly lower in the abdomen than the left, crosses the subcostal plane, and a small portion of its inferior extremity lies in the right lumbar and the adjoining part of the umbilical region. The difference between the two sides is probably due to the great bulk of the right lobe of the liver. On each side the twelfth rib lies behind the kidney, and the right kidney does not, as a rule, extend beyond the upper border of that rib, but the left kidney may reach the lower border of the eleventh rib. The lower end of each kidney is separated by a short but variable interval from the crest of the ilium.

The average length of a kidney is 10 cm. (four inches); its breadth is about 6 cm. (two and a half inches); and its average weight is 130 grms. (four and a half ounces) in the male, but somewhat less in the female. It is a solid organ, very pliable, and of a brownish-red colour. The left kidney is, as a rule, slightly longer and narrower than the right kidney.

Form of the Kidney.—The form of the kidney is so characteristic that the term "reniform," or "kidney-shaped," has become common in descriptive language. The *anterior surface* looks laterally and forwards, and presents impressions corresponding to the viscera in contact with it; whilst the *posterior surface* is directed medially and backwards, and is moulded accurately upon the parts which support it. The *extremities* are rounded, and the superior end is usually thicker and more massive than the inferior. The *lateral border*, smooth and convex, is directed backwards and laterally;

whilst the *medial border* is concave, and looks medially and forwards.

The kidneys present many changes in form, according to the amount and the kind of pressure which is exerted upon them by contiguous viscera. In most cases, however, and on both sides, there is on the anterior surface of the organ a point of maximum convexity—a place where the kidney substance is raised in the form of a marked prominence or bulging. Above and below that eminence the anterior surface falls away towards each extremity, in the form of an inclined or sloping plane of greater or less obliquity. The impressed districts indicate pressure exercised on the anterior surface of the kidney in two directions, and the intervening eminence is the result of the pressure and counterpressure. The characteristic appearance is more constant and better marked in the case of the left kidney.

Upon the upper part of the anterior surface of the *left kidney* are placed the left suprarenal gland, the stomach, the spleen, and the pancreas. They exercise, collectively, a downward and backward pressure, chiefly through changes in the condition of the stomach. Upon the lower part of the left kidney the counterpressure is produced by the intestinal canal, which, as a rule, presses upwards and backwards.

Resting upon the upper part of the *right kidney* is the liver, whilst in contact with the lower part is the colon. The colon presses on the kidney in an upward and backward direction. To that pressure the liver offers a passive resistance, except perhaps in the case of the slight influence which it conveys in a downward direction from the diaphragm, and in a backward direction from the anterior abdominal wall.

The pressure and counterpressure, which produce so marked a conformation of the anterior surface of each kidney, must exercise also an important influence in maintaining the organ in its place, and securing it in that part of the abdominal cavity in which it lies. Still, it is doubtful if the influences have so potent an effect on the right as on the left side. The right kidney is embedded to a greater or less extent in the liver, and the pressure of the liver no doubt exerts an influence in fixing the kidney in position.

Ligaments fixing the kidney to the abdominal wall are described, and it is easy to demonstrate that the extra-peri-

toneal tissue in which it lies becomes condensed in the regions above and below into indefinite fibrous lamellæ, but it is doubtful if these can have much effect in maintaining the kidney in its place.

Hilum of the Kidney.—The medial border of each kidney presents a longitudinal fissure called the *hilum*, for the admission and egress of the vessels, nerves, lymph vessels, and duct (Fig. 176). The hilum is bounded anteriorly and posteriorly by thick lips, and leads into a deep recess or cavity in the kidney, which is termed the *renal sinus.* The ureter and the renal vessels pass between the lips of the hilum. They will be found to have the following general relations

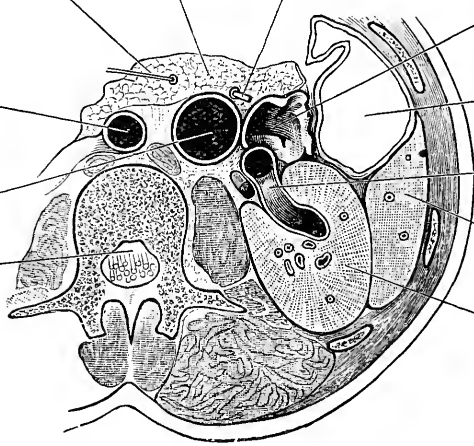

FIG. 176.—Section through Abdomen at the level of the second lumbar vertebra.

from before backwards: (1) branches of the renal vein; (2) branches of the renal artery; (3) ureter or renal duct.

Anterior Surface of the Right Kidney. — The anterior surface of the right kidney may present three impressions, viz. a hepatic, a colic, and a duodenal. The *hepatic impression*, which indicates the area of contact with the inferior surface of the right lobe of the liver, occupies almost the whole of the upper two-thirds of the anterior surface. Over that district the kidney is sometimes sunk deeply into the liver. The right suprarenal gland, which rests, as a rule, on the upper extremity of the right kidney, extends downwards, for a very short distance, on the anterior surface of the organ, between

it and the liver. With the exception of the narrow strip covered by the suprarenal gland, the hepatic area on the anterior surface of the kidney is covered with peritoneum. The *colic impression* corresponds to the lower part of the surface, and sometimes it exhibits a marked degree of obliquity. The right colic flexure and the commencement of the transverse colon are in contact with the colic area. The posterior surfaces of those portions of large intestine are devoid of peritoneum, and are bound to the kidney by

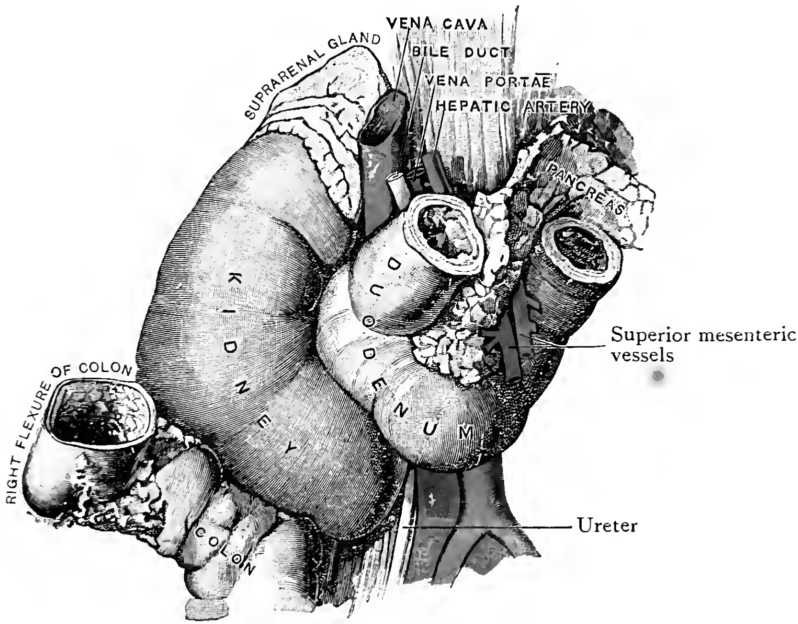

FIG. 177.—Right Kidney and Duodenum.

areolar tissue. The *duodenal impression*, or area of contact with the descending part of the duodenum, is in the neighbourhood of the hilum, and varies greatly both in position and extent (Figs. 155, 177).

The lower pole of the right kidney, and the area of the anterior surface between the suprarenal gland above, the colon below, and the duodenum medially are covered with peritoneum, but the peritoneum is separated from the remaining parts of the anterior surface by the viscera mentioned.

Anterior Surface of the Left Kidney.—The left suprarenal gland, the spleen, the stomach, and the pancreas are in

contact with the upper part on the anterior surface of the left kidney. The left *suprarenal gland*, as a rule, occupies a narrow district along the medial border, from the level of the hilum to the summit of the organ. The *spleen* is in contact over an area immediately adjoining the lateral convex border. The extent of the splenic field varies considerably in different subjects. The *pancreas* stretches across the left kidney about its middle. The *stomach* is in contact with the left kidney over the triangular interval which is left between the left suprarenal gland, the spleen, and the pancreas, and that

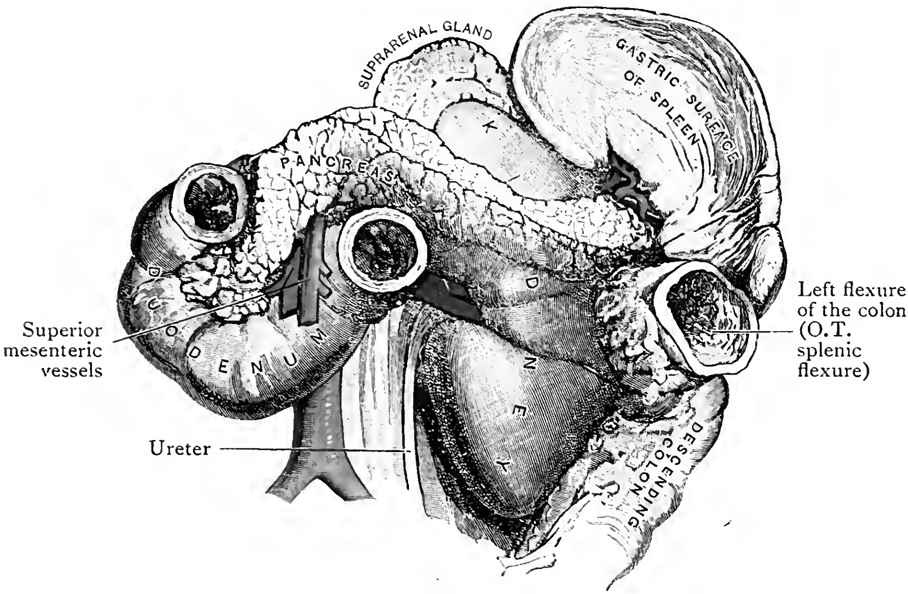

FIG. 178.—Relations of the Left Kidney and the Pancreas.

portion of the surface is covered with peritoneum of the omental bursa.

The lower part of the anterior aspect of the left kidney presents a varying relation to the intestinal canal. Towards the lateral border of the organ is the *descending colon*, whilst more medially the surface is in relation to coils of the *small intestine*.

The parts of the anterior surface of the left kidney which are directly covered with peritoneum are the parts above the pancreas in relation with the stomach and the spleen; the part below the pancreas and to the medial side of the descending colon.

Posterior Surfaces of the Kidneys.—The posterior surface of each kidney is mapped out into a medial and a lateral district. The *medial district* is the narrower of the two, and looks medially and backwards. It is in apposition with the psoas major muscle and the crus of the diaphragm, and it is separated from the lateral district by a rounded ridge, which corresponds to the angle between the planes of the psoas and quadratus lumborum muscles. The *lateral district* looks backwards. In its upper third it rests on the diaphragm, and in its lower two-thirds, upon the quadratus lumborum

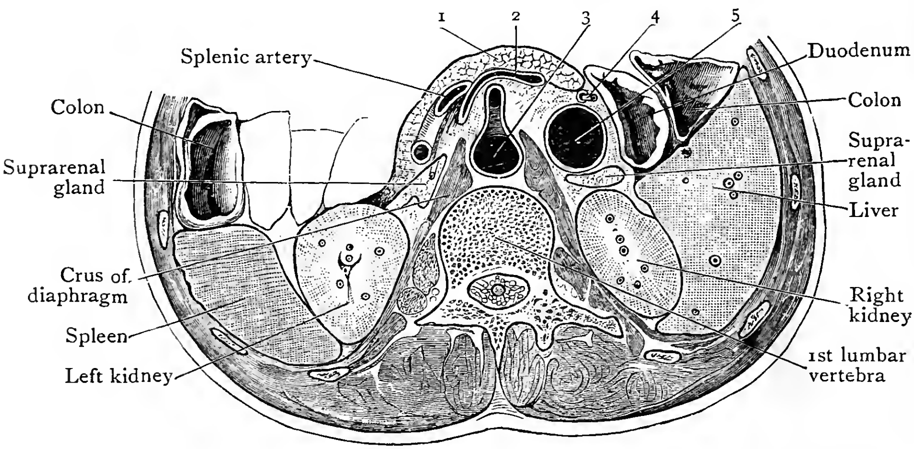

FIG. 179.—Transverse section through Abdomen at the level of the first lumbar vertebra.

1. Pancreas.
2. Splenic vein, joining the portal vein.
3. Aorta, giving off the superior mesenteric artery.
4. Rod in bile-duct.
5. Inferior vena cava.

and the aponeurosis of origin of the transversus muscle. The upper end of the kidney curves slightly forwards in correspondence with the diaphragm, on which it lies; and it should be borne in mind that between the diaphragm and the last rib the pleural cavity descends behind the kidney for a short distance (Fig. 180).

Additional posterior relations are:—the lumbo-costal arches; the last thoracic nerve and the sub-costal artery; and, at a lower level, the ilio-hypogastric nerve. The ilio-inguinal nerve may also be a posterior relation, but in many cases it lies below the level of the lower pole of the kidney.

In spare subjects, when the kidneys have been hardened

in situ, dimples, corresponding to the tips of the transverse processes of the first, second and third lumbar vertebræ, and a shallow groove for the last rib, may sometimes be detected on the posterior surface of the kidney. A furrow corresponding to the lateral lumbo-costal arch is sometimes to be seen on the posterior aspect of the kidney.

The student should never experience any difficulty in determining the side to which a given kidney belongs. Even

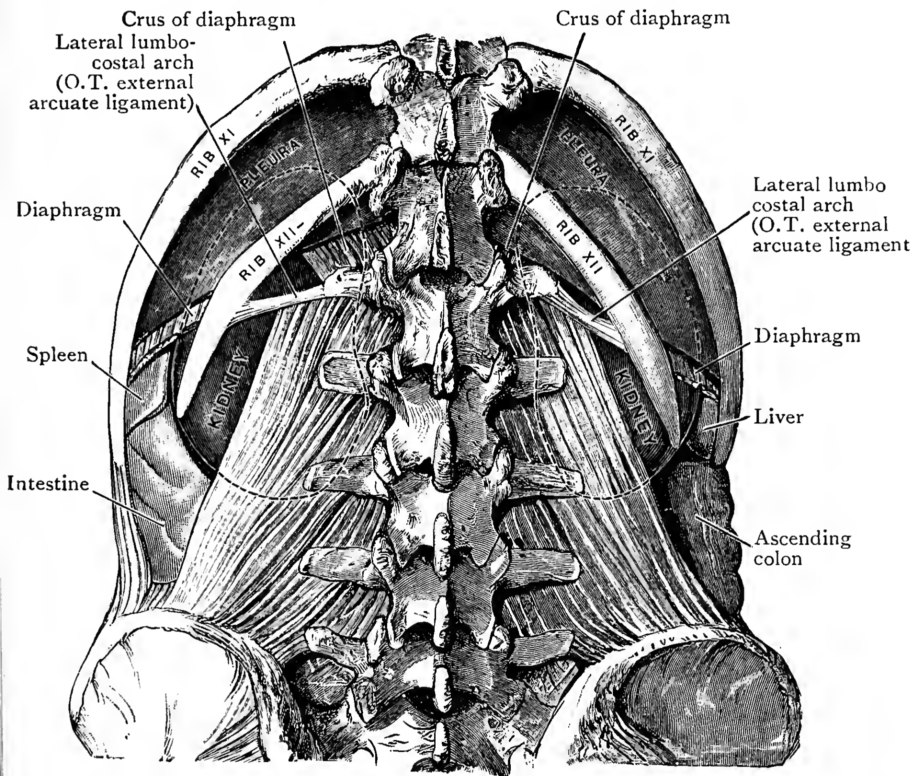

FIG. 180.—Dissection from behind to show the relation of the two Pleural Sacs to the Kidneys. Outline of upper portions of kidneys indicated by dotted lines.

allowing that the upper end cannot be distinguished from the lower end, or the anterior surface from the posterior surface, by differences in their appearance (which is frequently the case when the kidney has not been hardened *in situ*), the ureter alone is sufficient for the purpose. It lies next the posterior lip of the hilum, and it curves downwards towards the lower end of the kidney.

Kidney Capsule and Kidney Substance.—The kidney is invested by a strong fibrous capsule, which can be easily stripped from its surface. Divide the capsule along the lateral margin of the organ and peel it off towards the hilum. There it enters the renal sinus, lines the walls of the sinus, and becomes continuous with the sheaths of the vessels entering the gland, and also with the external coats of the calyces of the ureter.

Examine the manner in which the ureter or duct is connected with the kidney. As it approaches the hilum it expands into a wide funnel-shaped portion called the *pelvis* (Fig. 183).

The pelvis enters the sinus and divides into two, or perhaps three, large primary branches, and those again break up into a large number of short, stunted secondary divisions called *calyces*, which are attached to the walls of the sinus.

Dissection.—Divide the kidney into anterior and posterior parts. Take a large knife and carry it through the kidney from the lateral border to the hilum, parallel with and midway between the two surfaces. Then examine the cut surfaces and the contents of the sinus.

An examination of the cut surface of the kidney will show that its substance is arranged in two parts—a medullary and a cortical. The *medullary portion* consists of dark-coloured, faintly striated pyramidal masses, the bases of which are directed towards the periphery, whilst their apices are free and project into the sinus. On the sinus wall the apex of each medullary pyramid forms a prominent mamillary projection, called a *renal papilla*, which projects into one of the calyces of the pelvis of the ureter (Fig. 182). If the kidney is squeezed, fluid will be seen to exude from the papillæ, showing that the tubuli uriniferi open upon their surface. The number of pyramids and renal papillæ varies from eight to twenty. Usually there are more than twelve. A single calyx of the ureter may surround one, two, or even three renal papillæ; it receives the urine as it issues from the papillary ducts which open on their surfaces. The *cortical substance* constitutes the peripheral part of the gland, and also sends prolongations inwards between the pyramids. The prolongations of the cortex are called the *columnæ renales* (O.T. *columns of Bertin*).

Ureter.—The ureter is the duct which carries the urine from the kidney to the bladder. The relations of its ex-

panded upper end or pelvis at the hilum of the kidney have already been noted. After leaving the gland, it turns downwards and becomes contracted, so that when it reaches the level of the lower end of the kidney it has acquired the appearance of a cylindrical tube.

Each ureter extends downwards and medially, on the anterior surface of the psoas major muscle of the same side, to the lower end of the common iliac artery, or the upper end of the external iliac artery; there it leaves the abdomen proper and enters the pelvis minor, where it will be studied at a later period. As it dips into the pelvis minor the right ureter passes behind the termination of the ileum, and the left behind the pelvic colon; and as it lies on the front of the psoas major muscle each ureter crosses obliquely in front of the genito-femoral nerve of the same side. The anterior relations of the abdominal parts of the two ureters differ slightly from each other. The right ureter commences behind the descending part of the duodenum, and crosses behind the commencement of the inferior part; both parts, therefore, separate it from the peritoneum. Below the duodenum

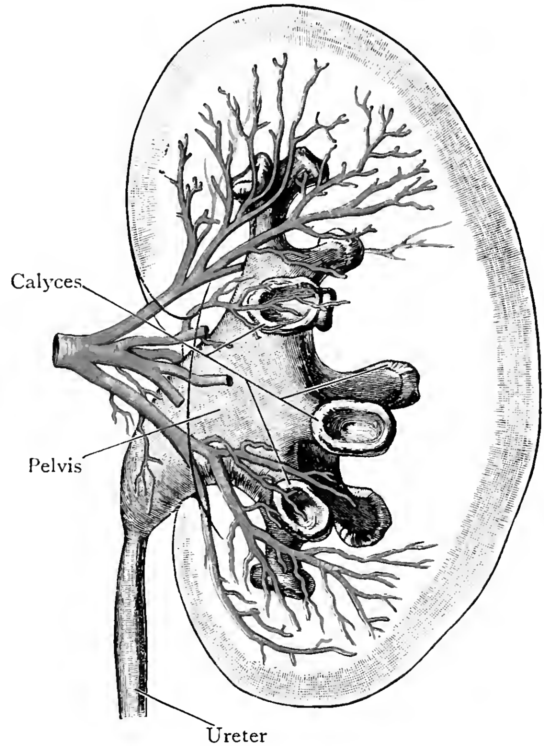

FIG. 181.—From a figure by Max Brödel to show the form of the Pelvis of the Ureter and the Calyces, as well as the relation of the main branches of the Renal Artery to these. The ureter, pelvis, calyces, and arteries were injected with celloidin, and then the kidney substance was removed by means of a digesting fluid. It is, thus, a cast of the pelvis and calyces which is represented, and the cupped appearance of each calyx shows the manner in which the corresponding renal papilla projects into the calyx.

it descends behind the peritoneum, from which it is partially separated by the right internal spermatic or ovarian vessels, the right colic and the ileo-colic vessels, and the terminal parts of the superior mesenteric artery and vein. The whole of the abdominal portion of the left ureter is in relation, in front, with the peritoneum, except that it is crossed anteriorly, behind the peritoneum, by the left internal spermatic or ovarian vessels, the left colic vessels, and the sigmoid vessels.

Dissection.—Having now studied all the viscera within the cavity of the abdomen proper, the student should, in the next place, direct his attention to the diaphragm—the great muscle which constitutes a movable partition between the thoracic and abdominal cavities. Strip the peritoneum from its lower, concave surface; clean the muscular fibres and the central tendinous expansion towards which they ascend, but be careful to preserve the inferior phrenic arteries, which ramify upon the inferior aspect of the diaphragm, and also the nerves which accompany them.

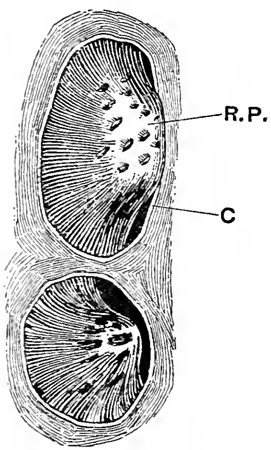

FIG. 182.—Diagram of two Renal Papillæ.

R.P. Renal papilla.

C. Cut edge of a calyx of the pelvis of the ureter.

Diaphragma.—The diaphragm, after the heart, is the most important muscle in the body. It forms the dome-shaped roof of the abdomen, and the highly arched and convex floor of the thorax. It is the chief muscle of respiration. Each respiratory act is accompanied by its descent and ascent, and in that way the capacity of the thoracic cavity is alternately increased and decreased in the vertical direction. The vault or cupola of the diaphragm is higher on the right side than on the left side of the body. In forced expiration it may rise, on the right side, as high as the upper margin of the fourth rib, in the right lateral line; whereas, on the left side, it reaches only as high as the upper border of the fifth rib (Fig. 36).

The *central portion* of the diaphragm is tendinous. From the tendon the fleshy fibres radiate, and at the same time arch downwards, to obtain attachment to the circumference of the lower aperture or outlet of the thorax. *Anteriorly*, the diaphragm takes origin from the posterior surface of the xiphoid process; *laterally*, it arises from the lower six costal

PLATE XVII

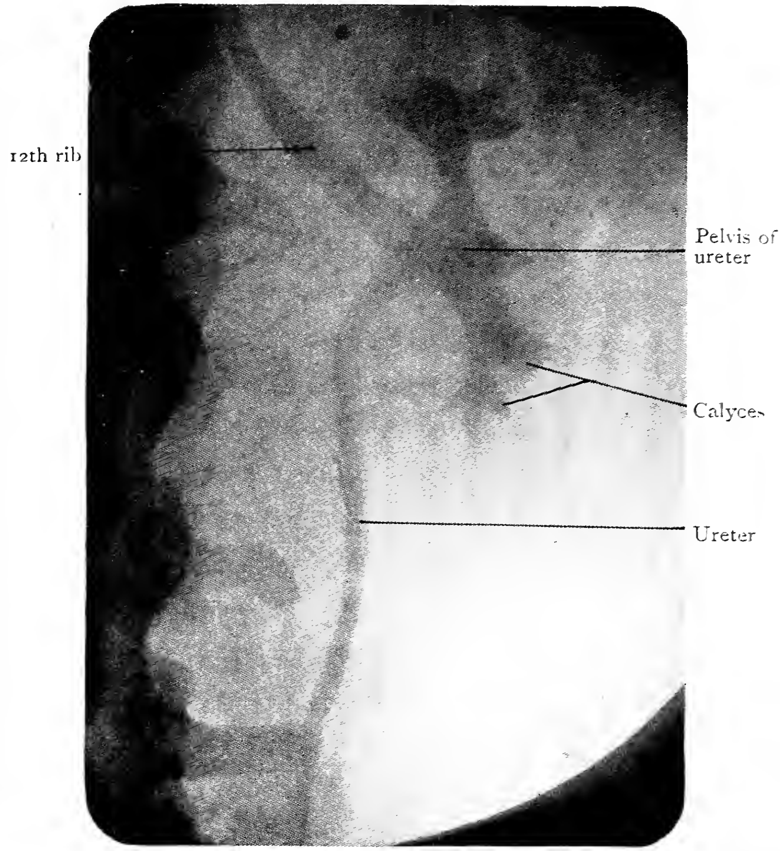

FIG. 183.—Radiograph of the Abdominal Part of the Left Ureter injected with collargol. (Frank Kidd, F.R.C.S.)

Note (1) The relation of the pelvis of the ureter to the last rib.
(2) That only relatively few calyces are shown.
(3) That the ureter does not possess the usual convex curve towards the median plane.

arches; *posteriorly*, it springs by two powerful, partly fleshy and partly tendinous processes, called *the crura*, from the bodies of the upper three lumbar vertebræ, and, on each side of those, from two ligamentous arches, termed the *lumbo-costal arches* (O.T. *ligamenta arcuata*) (Fig. 184).

Anterior Attachment.—The sternal origin consists of two fleshy slips which spring from the back of the xiphoid process. These are separated from each other by a narrow linear interval filled with areolar tissue, and comparable with the

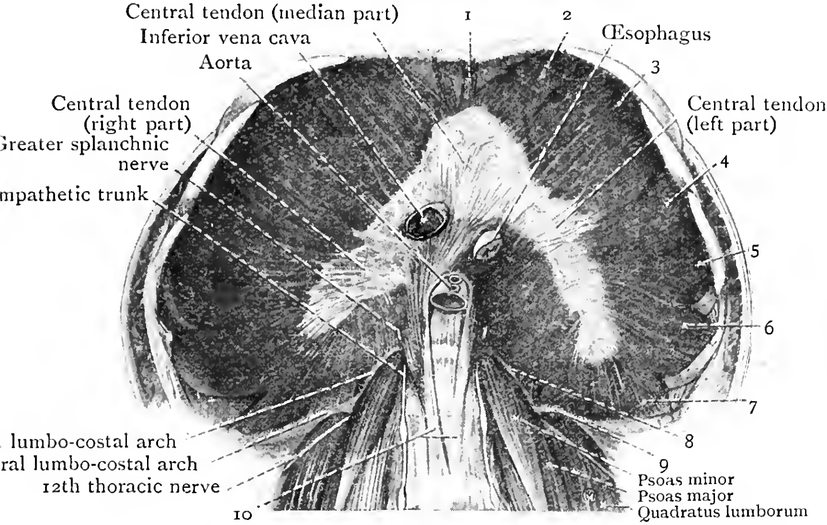

FIG. 184.—Semi-diagrammatic View of the Attachments of the Diaphragm.

1. Sternal origin (left).
2-7. Costal origins (left).
8. Medial lumbo-costal arch (left).
9. Lateral lumbo-costal arch (left).
10. Tendinous parts of the crura (left and right).

wider interval, in the median plane behind, which separates the two crura of the diaphragm.

Lateral Attachments.—The costal origin consists of six pointed and fleshy slips which spring from the deep surfaces of the lower six costal cartilages on each side. They interdigitate with the digitations of the transversus abdominis. The sternal and costal origins of the diaphragm, on each side, are separated by a small triangular interval in which the pleural and peritoneal membranes are separated from each other merely by some loose areolar tissue. Through the gap the superior epigastric branch of the internal mammary artery descends into the abdominal wall.

Posterior Attachment.—The *lateral lumbo-costal arch* (O.T. *ligamentum arcuatum externum*) is a fibrous band which stretches from the last rib to the transverse process of the first lumbar vertebra. It arches in front of the quadratus lumborum, and is merely the thickened upper part of the fascia which covers that muscle, *i.e.*, the anterior lamella of the lumbar fascia. If the rib is pressed backwards the arch will be rendered more distinct. The last thoracic nerve passes laterally and downwards behind the *lateral lumbo-costal arch.* The *medial lumbo-costal arch* (O.T. *ligamentum arcuatum internum*) arches over the psoas major muscle, and, like the lateral arch, is simply a thickening of the fascia which covers the muscle. It is the stronger of the two arches, and is attached by one extremity to the tip of the transverse process of the first lumbar vertebra, and by the other to the body of the second lumbar vertebra and the tendinous part of the corresponding crus of the diaphragm. Fleshy fibres arise from both of the arcuate bands; those from the medial arch are more numerous and better marked than those which take origin from the lateral arch, and they are continuous with the fleshy fibres of the crus. Very frequently a gap or interval exists between the fibres which spring from the lateral arch and those which arise directly from the last rib. The anterior, lateral, and posterior attachments of the diaphragm are therefore marked off by intervals from each other.

The *crura* of the diaphragm are two thick fleshy processes which descend upon the bodies of the upper lumbar vertebræ, tapering as they proceed downwards. They end in pointed tendinous extremities. The *right crus* is the larger and longer of the two. It takes origin to the right of the median plane from the bodies of the upper three lumbar vertebræ, and the intervertebral fibro-cartilages between them. The *left crus* is attached, on the left of the median plane, to the bodies of the first two lumbar vertebræ and the intervening fibro-cartilage. It is much smaller than the right crus. Follow the crura upwards; opposite the last thoracic vertebra they are connected across the middle line by a strong fibrous band which arches over the aorta. From the upper border of that fibrous arch fleshy fibres arise which join both crura; and on that account the arch is called the *ligamentum arcuatum medium.*

It may be regarded as a law that wherever an artery pierces the origin or insertion of a muscle, and comes to lie between bone and muscular

fibres, it is protected by a fibrous arch. Of this nature is the arch in question, and also the fibrous arch thrown over the profunda artery on the back of the humerus, and the fibrous arches in the adductor magnus for the passage of the perforating arteries, and of the femoral artery itself.

Above the level of the ligamentum arcuatum medium the fleshy fibres of the crura diverge and ascend to join the posterior border of the central tendon. The most medial fibres of each crus, however, decussate so as to separate the aortic from the œsophageal openings. The decussating fasciculus of the right crus is always the larger of the two, and, moreover, it frequently passes behind the decussating fasciculus of the left crus, but may pass in front of it (Fig. 184).

It is the custom of some authors to divide each crus into three parts, a lateral crus, an intermediate crus, and a medial crus. The lateral crus is formed by the fibres which spring from the medial lumbo-costal arch. It is separated from the intermediate crus by the sympathetic trunk. The intermediate crus is separated from the medial crus by the splanchnic nerves. In many cases, however, the subdivisions are not distinct.

Centrum Tendineum.—The central tendon of the diaphragm is exceedingly strong. It is composed of tendinous bundles running in different directions, and closely woven together in such a manner as to give it a plaited appearance. The appearance is well seen from the abdominal surface. The central tendon is somewhat semilunar in outline, with a broader and shorter right and a narrower and longer left horn. Upon all sides it is surrounded by muscular fibres of which those attached to the sternum are much the shortest.

Foramina of the Diaphragm.—The continuity of the diaphragm is broken by *three* large openings, and by some smaller apertures or fissures for the passage of the splanchnic nerves, and the vena hemiazygos. The three main openings receive the names of the most important objects which they transmit. They are—

1. The aortic.
2. The vena caval.
3. The œsophageal.

Hiatus Aorticus.—*The aortic opening* is in the median plane, in front of the first lumbar vertebra, and between the crura of the diaphragm. It is bounded in front by the fibrous middle arcuate ligament, which arches across the median plane and connects the tendinous portions of the two crura. The structures which pass through the aortic opening are—(1) the

aorta, (2) the thoracic duct, and (3) the vena azygos—in that order from left to right.

Foramen Venæ Cavæ.—The vena caval opening is at a higher level, being situated opposite the fibro-cartilage between the eighth and the ninth thoracic vertebræ, in front and slightly to the right of the aortic opening. It is placed in the posterior part of the central tendon at the junction between its middle and the right horn. Its form is somewhat quadrangular, and its margins are prolonged upon the walls of the vena cava as that vessel passes through it. The contraction of the muscular fibres of the diaphragm will therefore tend to increase the size of the opening and the calibre of the vein which it holds.

In addition to the vena cava, one or two minute twigs from the right phrenic nerve may be transmitted through the vena caval opening.

Hiatus Œsophageus.—The œsophageal opening is an oval or elliptical foramen in the muscular part of the diaphragm. It lies in front and slightly to the left of the aortic aperture, and also at a higher level, being placed opposite the tenth thoracic vertebra. In a few cases its upper or anterior border is tendinous, being formed by the posterior margin of the central tendon. Posteriorly, it is separated from the aortic opening by the decussation of the medial fibres of the crura.

The œsophageal opening transmits the œsophagus, the two vagi nerves, and some œsophageal vessels.

The three large openings of the diaphragm, therefore, present very different features. The *aortic opening* is bounded by a fibrous arch behind the diaphragm, and it can in no way be affected by the contraction of the muscular fibres. The *vena caval opening* is in the central tendon, and its margins are attached to the wall of the vessel which it transmits; contraction of the diaphragm must therefore have a tendency to open this aperture to its widest extent. The *œsophageal opening* is placed in the muscular part, and consequently it is probable that the fibres which surround it are capable of exercising a constricting influence upon the œsophagus, and in that way help to prevent regurgitation of food during the descent of the diaphragm.

Little need be said regarding the smaller foramina. Each crus is pierced by the *three splanchnic nerves*, and the left crus is perforated, in addition, by the *hemiazygos vein*. The

superior epigastric artery descends in the interval between the sternal and costal attachments of the diaphragm; and the *musculo-phrenic artery* passes between two slips of the costal attachment opposite the eighth or ninth rib.

Vessels on the Posterior Wall of the Abdomen.

Dissection.—The abdominal part of the aorta and its branches and the inferior vena cava must now be cleaned. As the dissection proceeds the dissector must take care to secure the gangliated trunks of the sympathetic, which extend downwards, on the vertebral column, along the anterior borders of the psoas major muscles. It is necessary to bear in mind that the lumbar branches of the aorta, as they proceed laterally, pass behind the sympathetic trunks. Separate the right crus of the diaphragm from the aorta, and dissect in the interval between them. There the cisterna chyli and the vena azygos will be found. A chain of lymph glands, termed the lumbar glands, will be noticed in relation to the aorta. The only branches of the aorta which are liable to injury are the internal spermatic arteries. They are two slender arteries which spring from the front of the aorta, a short distance below the renal arteries. They are so small that they are apt to be overlooked.

Aorta Descendens, pars Abdominalis.—The abdominal part of the aorta is the direct continuation of the thoracic part. It begins in the median plane, in the upper part of the aortic orifice of the diaphragm, in front of the lower border of the last thoracic vertebra; and it ends in front of the lower part of the body of the fourth lumbar vertebra, a little to the left of the median plane, by dividing into the two *common iliac arteries.* It therefore pursues an oblique course—inclining slightly to the left as it proceeds downwards. A line drawn between the highest points of the iliac crests would indicate the level of the bifurcation of the abdominal aorta, which takes place a little below and to the left of the umbilicus.

Most of the structures which lie *in front of* the abdominal aorta have been removed. In immediate relation to it from above downwards are:—(1) The cœliac plexus and the layer of peritoneum which forms the posterior wall of the omental bursa. (2) The pancreas and splenic vein. (3) The left renal vein and the third part of the duodenum. (4) The root of the mesentery and the superior mesenteric vessels. (5) The peritoneum and the aortic plexus of nerves. More

superficially it is covered by the lesser omentum; the liver; the stomach; the transverse colon and its mesentery; and by the great omentum and the coils of the small intestine. *Behind*, the abdominal aorta rests upon the bodies of the lumbar vertebræ and the intervertebral fibro-cartilages, separated from them, however, by the anterior longitudinal ligament and the left lumbar veins. *On each side*, it is related, in its upper part, to the crus of the diaphragm. *On the right side*, the inferior vena cava lies close to the aorta, as high as the second lumbar vertebra, but above that it is separated from the aorta by the fleshy part of the right crus. In the interval between the right crus of the diaphragm and the aorta, the dissector has already noted the cisterna chyli and the vena azygos. *On each side*, the gangliated trunk of the sympathetic is in relation to the artery, below the level of the crura of the diaphragm.

Branches of the Abdominal Aorta.—The branches of the abdominal aorta may be described under two heads, viz.—(1) Those which come off *in pairs*. (2) Those which arise *singly*.

Paired Branches.	Single Branches.
1. A. phrenica inferior.	1. A. cœliaca.
2. A. suprarenalis media.	2. A. mesenterica superior.
3. A. renalis.	3. A. mesenterica inferior.
4. A. spermatica interna.	4. A. sacralis media.
5. Aa. lumbales.	

With the exception of the *middle sacral*, which arises from the back of the extremity of the aorta, between the two common iliacs, the *single branches* have already been described. The middle sacral artery will be examined when the pelvis minor is dissected. The *paired branches* may now be examined.

The Inferior Phrenic Arteries have already been noticed upon the under surface of the diaphragm. They are two in number, and are the first branches which spring from the abdominal aorta. As they pass upwards and forwards they diverge from each other, the artery of the right side passes behind the inferior vena cava, whilst the artery of the left side goes behind the œsophagus. Near the posterior border of the central tendon of the diaphragm each divides into a lateral and a medial branch. The *lateral branch* proceeds laterally to anastomose with the intercostal arteries, whilst

the *medial branch* curves forwards to the front of the central tendon, and ends by anastomosing with its fellow and with the terminal branches of the internal mammary artery. Each inferior phrenic artery, in addition to the branches which it supplies to the diaphragm, gives a twig, called the *superior suprarenal artery*, to the suprarenal gland. The left artery sends a few minute branches to the œsophagus also.

The *inferior phrenic veins* open into the inferior vena cava.

The Middle Suprarenal Arteries (O.T. **Middle Capsular Arteries**) are two small vessels which arise, one from each side of the aorta, at the same level as the superior mesenteric. Each runs laterally and upwards, in front of a crus of the diaphragm, to the suprarenal gland, into the substance of which it sinks. The right middle suprarenal artery passes behind the inferior vena cava. They anastomose freely with the superior and inferior suprarenal arteries.

The *right suprarenal vein* opens into the inferior vena cava, whilst the *left suprarenal vein* ends in the left renal vein or in the left inferior phrenic vein.

The Renal Arteries.—When compared with the organs which they supply, the renal arteries are disproportionately large. Only a small part of the blood which they carry to the kidneys is used for the nourishment of the gland substance. The kidneys are excretory organs, and it is necessary that the blood should pass to them in large quantity in order that certain materials may be removed from it.

The renal arteries take origin, about a quarter of an inch below the superior mesenteric, at the level of the second lumbar vertebra. Each artery proceeds laterally, at right angles to the aorta, and, approaching the kidney, breaks up into three branches, which enter the hilum, and pass deeply into the renal sinus. Each artery is overlapped by the accompanying vein. The right artery is placed at a slightly lower level than the left, and passes behind the inferior vena cava. At the hilum two of the terminal branches, as a rule, lie between the renal vein and the pelvis of the ureter, whilst the third enters the sinus behind the pelvis of the ureter. In the renal sinus the three terminal branches break up into numerous smaller branches, which penetrate the kidney substance in the intervals between the renal papillæ (Fig. 181, p. 383).

The renal artery gives a small branch—the *inferior suprarenal*

—to the suprarenal gland, and also numerous fine twigs to the connective tissue around the kidney, and to the upper part of the ureter.

The *renal veins* join the inferior vena cava. The vein of the left side is the longer of the two. It lies behind the pancreas and crosses in front of the aorta immediately below the root of the superior mesenteric artery. It receives a tributary from the left suprarenal gland; it is joined also by the left internal spermatic or ovarian vein.

The Internal Spermatic Arteries are two long slender vessels which spring from the front of the abdominal aorta, a short way below the renal arteries. Diverging from its fellow, each artery passes obliquely downwards and laterally, behind the peritoneum, to the abdominal inguinal ring, where it joins the other factors of the spermatic cord. As it descends it rests upon the psoas major, and crosses anterior to the ureter and the lower end of the external iliac artery. On the right side the internal spermatic artery passes in front of the vena cava inferior and behind the terminal part of the ileum. On the left side it proceeds downwards behind the iliac colon (Fig. 156).

In the female the corresponding arteries go to the ovaries, and are consequently termed the *ovarian arteries*. Within the abdomen proper they have the same relations as the spermatic arteries, except that they cross the upper ends of the external iliac arteries. In the dissection of the female pelvis minor they will be followed to their destination.

The *right internal spermatic vein* joins the inferior vena cava directly, whilst the *left vein* terminates in the left renal vein. The *ovarian veins* end in the same manner.

The Lumbar Arteries are four in number on each side, and they spring from the posterior aspect of the abdominal aorta, in series with the intercostal arteries. At present only portions of them are visible. They proceed laterally upon the bodies of the upper four lumbar vertebræ, behind the gangliated trunk of the sympathetic, and then disappear under cover of the psoas major muscle and of the series of fibrous arches from which the muscle arises. The upper two arteries pass behind the crura of the diaphragm also, and on the right side all pass behind the inferior vena cava.

The *lumbar veins* join the inferior vena cava, those of the

left side passing behind the aorta on their way to their terminations.

Vena Cava Inferior.—The inferior vena cava is the large vein which collects, by means of its tributaries, the venous blood from the lower limbs, the abdominal viscera, and a

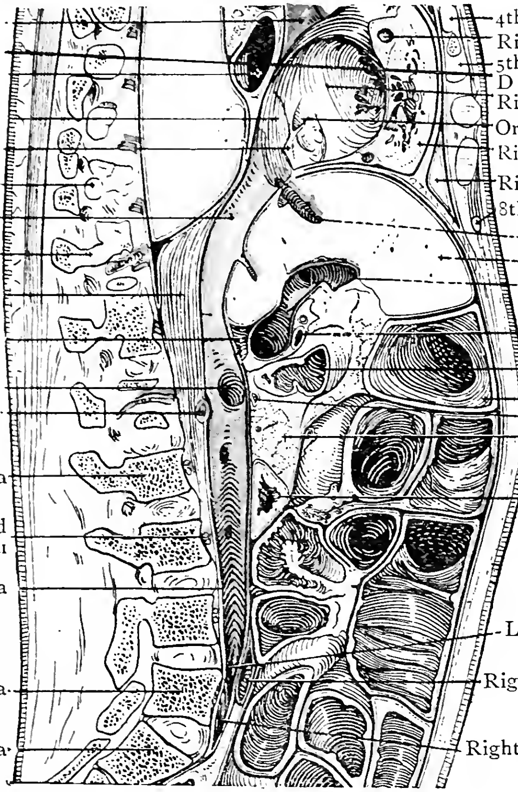

FIG. 185.—Sagittal section of the upper part of the Abdomen and the lower part of the Thorax of a Young Male Adult along the line of the Inferior Vena Cava.

D-D, Plan of Section shown in Fig. 21.

Note that the foramen epiploicum lies between the inferior vena cava, which is behind it, and the portal vein, which is in front of it.

great part of the abdominal parietes. It is formed by the union of the two *common iliac veins*, to the right of the median plane in front of the fifth lumbar vertebra and behind the right common iliac artery (Fig. 185). As it ascends it lies at first at the right side of the aorta, in front of the bodies of the vertebræ and the medial part of the right psoas major, but it is separated from the vertebral bodies by the

anterior longitudinal ligament and the lower right lumbar arteries, and from the anterior border of the psoas major by the right sympathetic trunk. Above the lower border of the second lumbar vertebra it is separated from the aorta by the right crus of the diaphragm. The right renal artery, the right cœliac ganglion, the right suprarenal artery, the right inferior phrenic artery, and the medial part of the anterior surface of the right suprarenal gland intervene between it and the right crus. At its commencement it lies behind the right common iliac artery; then it is crossed by the root of the mesentery and the superior mesenteric vessels. For a short distance above the root of the mesentery it is in direct relation with the peritoneum. At the level of the third lumbar vertebra it is crossed by the inferior part of the duodenum and the right internal spermatic or ovarian artery. Next, the head of the pancreas and the pancreatico-duodenal arteries are in front of it, and the bile-duct descends in front of its lateral border. Above the head of the pancreas it passes behind the first part of the duodenum, from which it is separated by the portal vein; then it ascends behind the epiploic foramen; and, finally, it lies in the vena caval fossa on the posterior surface of the liver, and the hepatic veins open into the uppermost part of it anteriorly.

It receives the following tributaries :—

1. The common iliac veins.
2. The lumbar veins.
3. The right internal spermatic or ovarian vein.
4. The renal veins.
5. The right suprarenal vein.
6. The inferior phrenic veins.
7. The hepatic veins.

Arteriæ Iliacæ Communes.—The two common iliac arteries, which are the terminal branches of the aorta, should next be examined. They arise upon the front of the body of the fourth lumbar vertebra, to the left of the median plane, and, diverging from each other, proceed downwards and laterally upon the vertebral column. After a course of about 50 mm. (two inches), each vessel ends opposite the corresponding sacro-iliac articulation, at the level of the lumbo-sacral articulation, by dividing into an *external iliac* and a *hypogastric* (O.T. *internal iliac*) branch; the external iliac is the larger of the two branches, and appears to be the continuation of the parent trunk, whilst the hypogastric artery, which was

the original continuation, passes downwards and backwards into the pelvis minor.

The common iliac artery of each side is covered by peritoneum, and overlapped by coils of the small intestine; furthermore, it is crossed by the large sympathetic twigs which connect the aortic and hypogastric plexuses, and, close to its termination, by the ureter. On the left side the superior hæmorrhoidal vessels also pass in front of the common iliac artery medial to the ureter.

The left common iliac artery is in relation posteriorly with the bodies of the last two lumbar vertebræ, the left sympathetic trunk and the medial margin of the left psoas major muscle. The right artery is separated from the vertebræ and the sympathetic trunk by the two common iliac veins and the commencement of the inferior vena cava.

No collateral branches of any consequence proceed from the common iliac arteries.

Venæ Iliacæ Communes.—Each of the two common iliac veins is formed by the junction of the external iliac and hypogastric veins of the corresponding side, the junction taking place behind the upper end of the hypogastric artery. The *left common iliac vein* is much longer than the right, and stands in relation to both common iliac arteries. It first lies along the *medial* or *right* side of its companion artery, and on a posterior plane; then it passes *behind* the upper part of the right artery to reach the vena cava inferior. The *right common iliac vein* lies *behind* its companion artery, and behind the upper part of the artery it joins with the left vein to form the inferior vena cava.

Tributaries.—In addition to the external iliac and hypogastric veins, by the union of which it is formed, the common iliac vein of each side is joined by an *ilio-lumbar vein.* The left common iliac vein receives, in addition, the *middle sacral vein.*

Arteriæ Iliacæ Externæ.—Each external iliac artery is the first or abdominal portion of the great arterial trunk which carries blood to the lower limb. It begins opposite the corresponding sacro-iliac articulation, at the level of the lumbosacral articulation, and extends obliquely downwards and laterally, along the brim of the pelvis minor, to the inguinal ligament, behind which it passes into the thigh, and becomes the *femoral artery.* Its course is indicated on the surface by

the lower two-thirds of a line drawn from a point a little below and to the left side of the umbilicus to a point midway between the symphysis pubis and the anterior superior spine

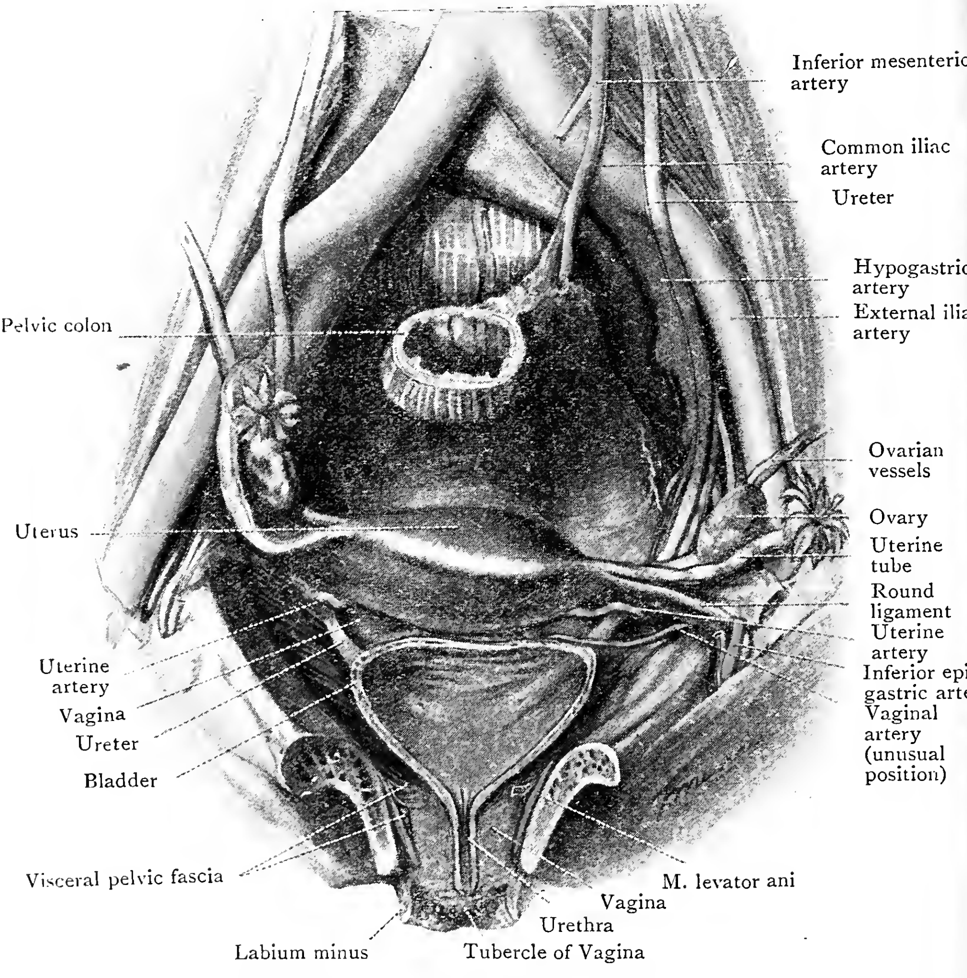

FIG. 186.—Dissection of the Pelvis of a multiparous female, showing the relations of the Bladder to the Uterus and Vagina, the relations of the Vagina to the Urethra and Broad Ligaments, and the relations of the Ureters to the Broad Ligaments and Vagina.

of the ilium. The upper third of the line indicates the position of the common iliac artery.

The external iliac, like the common iliac artery, is in close relation with the peritoneum which covers it anteriorly and medially. The right artery passes behind the terminal part of the ileum, and the left passes behind the pelvic colon.

Towards its termination each external iliac artery is crossed by the deep circumflex iliac vein, and the external spermatic nerve (O.T. genital branch of genito-crural). In the male, the terminal part of the artery is crossed also by the ductus deferens and the internal spermatic vessels, and in the female, by the round ligament of the uterus. At first the external iliac artery rests upon the medial margin of the psoas major muscle, but close to the inguinal ligament it comes to lie directly in front of that muscle. The artery is separated from the muscle, however, by the fascia iliaca, to which it is bound down by a condensed part of the extra-peritoneal tissue. The genito-femoral nerve lies along the lateral side of the artery, and the external iliac vein is placed on its medial side, on a posterior plane; on the right side, however, the vein, as it passes upwards, gradually comes to lie behind the artery.

Branches.—Each external iliac artery gives off two large branches to the abdominal wall, viz.—(1) the inferior epigastric; (2) the deep circumflex iliac. They arise close to the inguinal ligament, and have both been examined (pp. 228, 229). The corresponding veins open into the external iliac vein.

Venæ Iliacæ Externæ.—The external iliac veins are the continuations of the femoral veins. Each external iliac vein commences, therefore, at the upper border of the inguinal ligament, where the femoral vein terminates. As it ascends in the abdomen it lies along the brim of the pelvis minor, on the medial side of the corresponding external iliac artery, but on a more posterior plane. Just before it terminates, by joining the hypogastric vein to form the common iliac vein, it passes lateral to the upper end of the hypogastric artery, and between that artery and the medial border of the psoas major muscle.

Tributaries.—Each external iliac vein receives two tributaries, which are the inferior epigastric and the deep circumflex iliac veins of the same side.

Deep Lymph Glands.—The dissector has, doubtless, noticed a chain of lymph glands in connection with the external iliac artery, the common iliac artery, and also extending upwards upon the vertebral column in relation to the aorta and inferior vena cava. The *external iliac glands* are in two groups—a lower and an upper. The former consists of

three glands placed one on each side and one in front of the external iliac artery, and immediately above the inguinal ligament. The medial gland receives the deep femoral lymph vessels; into the anterior gland is poured the lymph which is drained from the district supplied by the inferior epigastric artery; whilst the lateral gland receives the lymph from the district supplied by the deep circumflex iliac artery. The efferent vessels from the lower group enter the higher group of glands, and from those the lymph is passed on to the common iliac and lumbar glands.

The common iliac glands lie alongside the common iliac arteries. They receive the efferents of the external iliac and hypogastric glands, and their own efferents pass to the lumbar lymph glands.

The glands in relation to each side of the aorta and inferior vena cava are both numerous and large, and are called the *lumbar lymph glands.* Their efferent vessels terminate in two common lumbar lymph trunks, which open into the cisterna chyli.

Cisterna Chyli (O.T. **Receptaculum Chyli**).—The cisterna chyli is the dilated commencement of the thoracic duct. It is placed upon the bodies of the first and second lumbar vertebræ, in the interval between the right crus of the diaphragm and the aorta. To bring it into view, it is necessary to separate the right crus from the lumbar vertebræ and pull it aside. When fully displayed, the cisterna chyli is seen to be a narrow elongated sac, about two inches in length, which receives at its lower end the two common lumbar lymph trunks, whilst, superiorly, it contracts and becomes the thoracic duct. About its middle it is joined, anteriorly, by the intestinal lymph trunk. Entering it near its upper end are two lymph trunks which carry lymph from the lower intercostal glands; they reach it by passing downwards through the aortic opening. The vena azygos lies along its right side, but the cisterna chyli is easily distinguished from the vein by the whiteness of its walls. The thoracic duct enters the thorax by passing through the aortic opening of the diaphragm.

Vena Azygos.—The *azygos vein* (O.T. *vena azygos major*) takes origin as the continuation of the right ascending lumbar vein (p. 408), or from the back of the inferior vena cava. It will be found in the interval between the right crus of the diaphragm and the aorta, upon the right side of the cisterna

chyli. It enters the thorax by passing through the aortic opening of the diaphragm.

Vena Hemiazygos (O.T. **Vena Azygos Minor Inferior**).—The *hemiazygos vein* is more difficult to discover. It originates on the left side of the vertebral column, usually as the continuation of the left ascending lumbar vein, but, occasionally, it springs from the left renal vein. It enters the posterior mediastinum of the thorax after piercing the left crus of the diaphragm.

Fascia and Muscles on the Posterior Wall of the Abdomen.

The muscles on the posterior wall of the abdomen on each side are three in number, viz.—(1) the *psoas major*, an elongated fleshy mass which lies on the side of the vertebral column; (2) the *quadratus lumborum*, a quadrate muscle lateral to the psoas, and extending from the crest of the ilium to the last rib; (3) the *iliacus*, situated in the iliac fossa. The fascia which covers the muscles must be studied first.

Quadratus Lumborum Fascia.—When the fascia which covers the anterior surface of the quadratus lumborum muscle is followed medially it will be found to be attached to the medial ends of the anterior surfaces of the transverse processes of the lumbar vertebræ. Traced laterally it will be found to join the posterior aponeurosis of the transversus abdominis muscle. The dissector will understand, from the connections of the fascia, that it is simply the anterior lamella of the lumbar fascia. Above, it is fixed to the last rib, and is thickened to form the *lateral lumbo-costal arch*, whilst inferiorly it blends with the ilio-lumbar ligament. The quadratus lumborum muscle, therefore, is enclosed in a sheath formed anteriorly by the anterior lamella of the lumbar fascia, and posteriorly by the middle lamella of the lumbar fascia (Fig. 114, p. 249).

Fascia covering the Psoas and Iliacus.—One continuous membranous sheet of fascia covers the anterior surfaces of the psoas and iliacus muscles on each side. *Above* the level of the crest of the ilium, where it is in relation only to the psoas, it is thin and narrow. There it is attached laterally to the fascia covering the quadratus lumborum, whilst medially

it is fixed to the vertebral column by a series of fibrous arches which bridge over the lumbar arteries. Superiorly, it thickened to form the band termed the medial lumbo-costal arch. *Inferiorly*, the fascia expands so as to cover both the psoas and the iliacus; at the same time it becomes much denser and thicker and is called the *fascia iliaca*. The fascia iliaca has important connections and relations. The external iliac vessels lie upon it, whilst the femoral nerve lies behind it. The genito-femoral nerve pierces it, and comes into relation with the external iliac artery. Laterally, it is firmly fixed to the crest of the ilium; medially, it sweeps over the psoas, and is attached to the brim of the pelvis minor. The attachments mentioned can be easily demonstrated if the fascia is divided in the vertical direction, over the iliacus, a short way to the lateral side of the psoas, and is then reflected medially and laterally. It is very loosely attached to the subjacent muscles, so that the fingers can readily be passed behind it, first in a lateral and then in a medial direction. Note that no perceptible fascial partition dips backwards from it between the psoas and iliacus.

The inferior connections of this fascia have already been studied (Vol. I., p. 240). On the lateral side of the iliac vessels it has been seen to become continuous with the fascia transversalis, and, at the same time, to be attached to the inguinal ligament; whilst behind the femoral vessels it is carried downwards into the thigh, to form the posterior wall of the femoral sheath.

Surgical Anatomy.—The attachments of the ilio-psoas fascia are of high surgical importance. When an abscess forms in connection with the lumbar vertebræ the pus readily passes downwards within the psoas sheath, and in certain cases is conducted behind the inguinal ligament so as to point in the thigh. It cannot enter the pelvis minor owing to the attachment of the fascia iliaca to the ilio-pectineal line.

Dissection.—The muscles should now be cleaned and their attachments defined; but, while that is being done, certain points must be attended to. The medial portion of the fascia iliaca must be preserved, in order that its relation to the pelvic fascia may be afterwards made out. In the case of the psoas major muscle, care must be taken not to injure—(1) the sympathetic trunk, which lies along its anterior margin; (2) the genito-femoral nerve, which runs downwards on its anterior surface; (3) the ilio-inguinal nerve, and the lateral cutaneous nerve of the thigh, which appear at its lateral border; and (4) the femoral nerve, which lies in the interval between it and the iliacus muscle. In the case of the quadratus lumborum, bear in mind that the

last thoracic nerve runs laterally in front of that muscle, close to the lower border of the last rib, and that the ilio-hypogastric and ilio-inguinal nerves cross it obliquely at a lower level.

M. Quadratus Lumborum.—The quadratus lumborum muscle *arises* from the ilio-lumbar ligament and from the crest of the ilium behind that ligament. It receives two or three slips also from the transverse processes of a corresponding number of the lower lumbar vertebræ. As it passes upwards it narrows slightly, and it is *inserted* into the medial half of the last rib behind the lateral lumbo-costal arch, and by four tendinous slips into the tips of the transverse processes of the upper four lumbar vertebræ. It is supplied by the anterior rami of the upper four lumbar nerves. It is a lateral flexor of the vertebral column, and acting with its fellow of the opposite side it is a muscle of inspiration, for it helps to fix the lower ribs and so converts them into fixed points from which the diaphragm can act.

M. Psoas Major.—The psoas major muscle has three distinct series of origins from the corresponding side of the vertebral column. It arises:—(1) by five fleshy processes from the anterior surfaces and lower borders of the transverse processes of the lumbar vertebræ, close to their roots; (2) by five slips, each of which arises from the intervertebral fibro-cartilage and the contiguous margins of the bodies of two vertebræ—the first slip springing from the last thoracic and the first lumbar vertebræ and the intervening fibro-cartilage, and the last slip from the lower two lumbar vertebræ and the intervening fibro-cartilage; (3) from the tendinous arches which bridge over the lumbar arteries and protect those vessels from the pressure of the contracting muscle.

The psoas major tapers somewhat as it extends downwards along the brim of the pelvis minor, and a tendon appears on its lateral border, which affords attachment to the fibres of the iliacus. Passing behind the inguinal ligament, it is inserted into the lesser trochanter of the femur.

It is supplied by the anterior rami of the second, third, and fourth lumbar nerves.

Another muscle, called the *psoas minor*, is occasionally present. It springs from the bodies of the last thoracic and first lumbar vertebræ, and the intervertebral fibro-cartilage between them, and, stretching downwards upon the anterior and medial aspect of the psoas major, it ends in a tendon which is inserted into the ilio-pectineal eminence and ilio-pectineal line.

M. Iliacus.—The iliacus muscle arises from the upper part of the iliac fossa, the anterior sacro-iliac ligament, and the base of the sacrum. It is inserted into the tendon of the psoas major. Some of its fibres, however, have a separate insertion into an impression below the lesser trochanter of the femur.

It is supplied by a branch of the femoral nerve; together with the psoas major, it acts as a flexor and medial rotator of the femur until the hip-joint is flexed, and then the two muscles rotate the femur laterally.

Nerves on the Posterior Wall of the Abdomen.

The nerves on the posterior wall of the abdomen are the gangliated trunk of the sympathetic and the anterior rami of the spinal nerves, with the branches which proceed from them. These should now be dissected.

> ***Dissection.***—**Clean the sympathetic trunks, one on each side. They will be found along the anterior borders of the psoas major muscles. On their lateral sides secure the branches which connect their ganglia with the lumbar nerves, and on their medial sides the branches they give to the aortic and hypogastric plexuses. On the right side the inferior vena cava must be displaced laterally to expose the right sympathetic trunk.**

Truncus Sympathicus.—On each side, the sympathetic trunk enters the abdomen behind the medial lumbo-costal arch, and extends downwards upon the bodies of the lumbar vertebræ along the anterior border of the psoas major muscle. *Superiorly*, it is continuous with the thoracic portion of the trunk, whilst *inferiorly*, it passes behind the common iliac artery and enters the pelvis minor. In the thorax, it is placed upon the heads of the ribs; in the abdomen it lies nearer the median plane, being carried forwards by the psoas major muscle. On the right side it is covered by the inferior vena cava, and on both sides the lumbar vessels pass behind it. As a general rule, a small oval ganglion is formed upon it opposite the body of each lumbar vertebra. *Rami communicantes* and *peripheral branches of distribution* proceed from the gangliated trunk.

The *rami communicantes* connect the ganglia with the anterior rami of the lumbar spinal nerves. One or more will be found accompanying each lumbar artery. Trace them backwards by cutting through the fibrous arches which bridge

over the arteries and scraping away the fibres of the psoas muscle. They join the lumbar nerves close to the intervertebral foramina.

The rami communicantes consist of two sets, viz., white and grey. The *white rami communicantes* are composed of medullated fibres which pass from the spinal nerves to the gangliated trunk. In the lumbar region there are only two or at most three white rami, and they proceed from the upper two or three lumbar nerves. The *grey rami communicantes* are much more numerous, and are formed of fibres which stream out in an irregular manner from the sympathetic trunk to the anterior rami of all the lumbar nerves.

The *peripheral branches of distribution* consist of a large number of small filaments which arise irregularly from the lumbar gangliated trunk, and pass medially, mainly to the aortic plexus, but some of the lower twigs go to the hypogastric plexus.

Dissection.—**To bring the anterior rami of the lumbar nerves into view, scrape away the remains of the psoas major muscle, which was partially destroyed when the connecting sympathetic twigs were followed backwards. An occasional branch, the** ***accessory obturator nerve,*** **is liable to injury unless it is secured at once. When present, it will be found descending along the medial border of the psoas major.**

Lumbar Nerves.—The anterior rami of the lumbar nerves are five in number, they pass laterally through the substance of the psoas major muscle. They increase in size from above downwards, and each nerve is connected by one or more twigs to the sympathetic trunk. Branches are given by the upper four nerves to the quadratus lumborum and by the second, third, and fourth to the psoas major.

The first *three* lumbar nerves, with a part of the *fourth*, unite in a loop-like manner to form the *lumbar plexus*, whilst the remaining part of the *fourth* joins the *fifth* to form the *lumbo-sacral trunk*. The fourth lumbar nerve is frequently called the *nervus furcalis*, because it divides to take part in the formation of both the lumbar and sacral plexuses.

Plexus Lumbalis.—The lumbar plexus is placed in front of the transverse processes of the lumbar vertebræ, in the substance of the psoas major. *Superiorly*, it is usually connected with the last thoracic nerve by a small twig which descends, in the substance of the psoas, to the first lumbar nerve; *inferiorly*, it is brought into communication with the sacral plexus by the branch of the fourth nerve which enters into the formation of the lumbo-sacral trunk.

The following are the branches which proceed from the lumbar plexus :—

1. N. ilio-hypogastricus, } derived from 1st lumbar nerve.
2. N. ilio-inguinalis, }
3. N. genito-femoralis, ,, 1st and 2nd lumbar nerves.
4. N. cutaneus femoris lateralis, ,, 2nd and 3rd lumbar nerves.
5. N. obturatorius, ,, 2nd, 3rd and 4th lumbar nerves.
6. N. femoralis, ,, 2nd, 3rd and 4th lumbar nerves.
7. Rami musculares to the quadratus lumborum and psoas major muscles ; these branches arise somewhat irregularly.

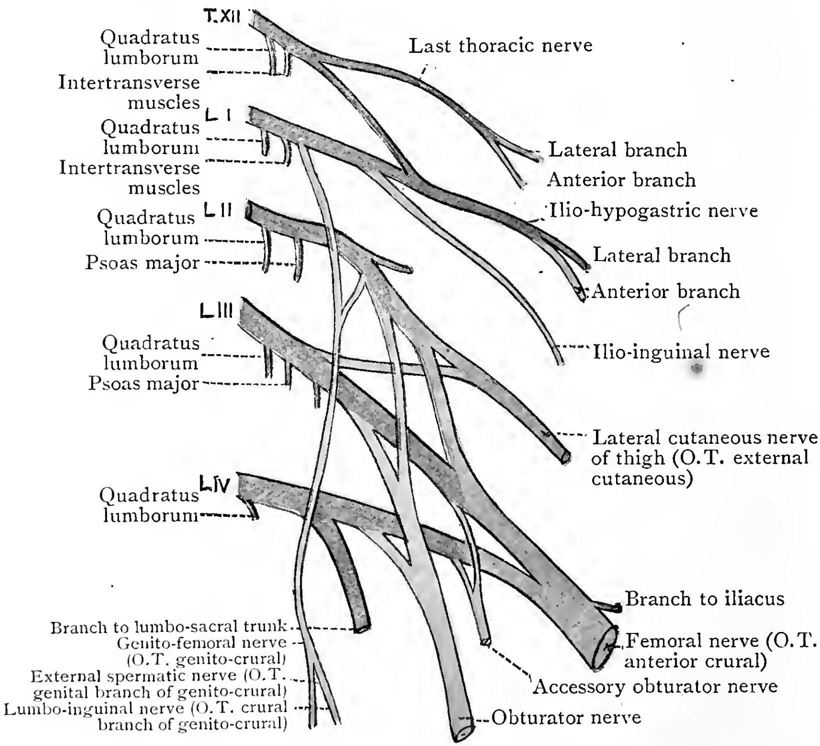

FIG. 187.—Diagram of Lumbar Plexus.

The manner in which the nerves spring from the plexus may now be studied. The *first lumbar trunk* breaks up into three branches, viz., the ilio-hypogastric, the ilio-inguinal, and the upper root of the genito-femoral. The *second*, *third*, and *fourth lumbar trunks* each divide into an anterior and a posterior division. The three anterior divisions are smaller than the posterior, and they unite to form the obturator nerve ; the three large posterior divisions unite to form the femoral nerve. But other branches come off from certain of the

divisions. Thus, the lower root of the genito-femoral springs from the anterior division of the second lumbar nerve, whilst the two roots of the lateral cutaneous nerve of the thigh take origin from the posterior divisions of the second and third lumbar trunks.

The *ilio-hypogastric nerve* emerges from the lateral border of the psoas, and crosses the quadratus lumborum obliquely. At the crest of the ilium, it leaves the abdomen by piercing the transversus abdominis muscle. Its further course has already

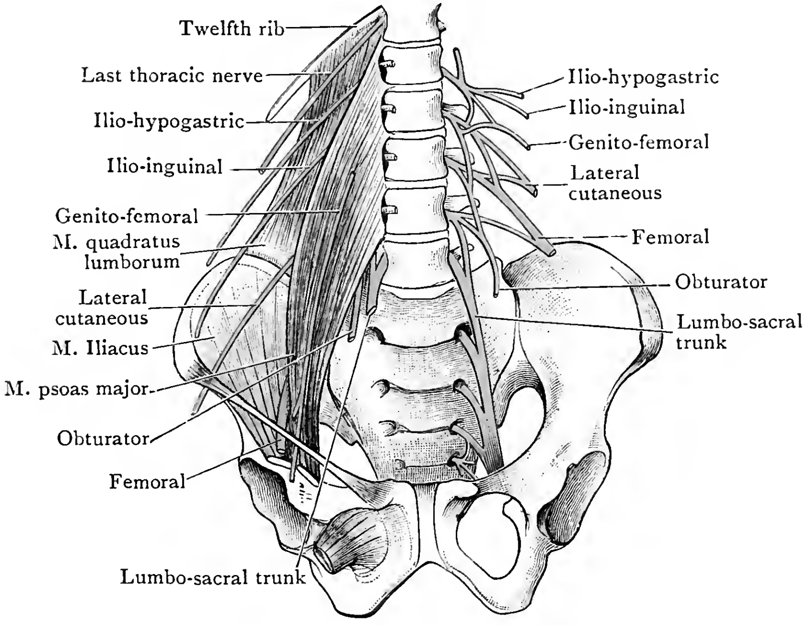

FIG. 188.—The Lumbar Plexus (semi-diagrammatic).

been studied (p. 217). It gives off a *lateral cutaneous branch* to the skin of the gluteal region, and an *anterior cutaneous branch* to the skin over the lower part of the abdominal wall.

The *ilio-inguinal nerve* leaves the psoas major immediately below the ilio-hypogastric nerve. It runs obliquely downwards and laterally over the quadratus lumborum and the upper part of the iliacus, and disappears from view by piercing the transversus abdominis muscle, a short distance anterior to the point where the ilio-hypogastric pierces that muscle. It is distributed to the integument of the scrotum in the male, and the labium majus in the female, and to the skin

of the medial aspect of the proximal part of the thigh (pp. 217 and Vol. I., p. 231).

The *genito-femoral nerve* (O.T. *genito-crural nerve*) is directed forwards through the psoas major, and appears upon its anterior aspect, where it ends by dividing into a lumbo-inguinal and an external spermatic branch. The *external spermatic branch* proceeds downwards and medially. It crosses the lower end of the external iliac artery obliquely, and reaches the abdominal inguinal ring. There it comes into relation with the constituents of the spermatic cord, and, leaving the abdomen, is distributed to the cremaster muscle. In the female it is a small branch, and it ends in the round ligament of the uterus and the labium pudendi. The *lumbo-inguinal branch* runs downwards along the lateral side of the external iliac artery, and, after crossing the deep circumflex iliac artery, it passes behind the inguinal ligament. Then it descends along the side of the femoral artery and after piercing the iliac part of the fascia lata it supplies the skin over a portion of the femoral triangle.

The *lateral cutaneous nerve of the thigh* (O.T. *external cutaneous nerve*) emerges from the lateral border of the psoas major about its middle, and descends obliquely across the iliacus muscle, behind the fascia iliaca, to the anterior superior spine of the ilium. At that point it leaves the abdomen by passing behind the inguinal ligament. It supplies the skin upon the lateral and anterior aspect of the thigh.

The *femoral nerve* (O.T. *anterior crural nerve*) is the largest branch of the plexus. It runs downwards in the interval between the psoas major and iliacus, and passes out of the abdomen behind the inguinal ligament. It gives a branch to the iliacus muscle.

The *obturator nerve* emerges from the medial border of the psoas major, where that muscle reaches the brim of the pelvis minor. Then it passes forwards and downwards upon the inner surface of the wall of the pelvis minor, a short way below the ilio-pectineal line of the hip bone. At the upper part of the obturator foramen it joins the artery of the same name, passes out from the pelvis minor and enters the thigh.

A small nerve, called the *accessory obturator*, is occasionally found. It may spring either from the obturator or from the third and fourth lumbar nerves. It proceeds downwards

along the medial side of the psoas major, and it enters the thigh by passing over the pubic bone under cover of the pectineus. In the thigh it gives branches to the hip-joint, and unites with the obturator nerve. It sometimes supplies a twig to the pectineus muscle.

Truncus Lumbosacralis (O.T. **Lumbo-sacral Cord).**—The lumbo-sacral trunk is formed by the union of the anterior ramus of the fifth lumbar nerve with the descending branch of the fourth lumbar nerve. It passes downwards over the base of the sacrum, behind the common iliac artery, into the pelvis minor, where it joins the sacral plexus.

Last Thoracic Nerve.—The anterior ramus of the last thoracic nerve will be found running laterally in front of the quadratus lumborum, and under cover of the fascia spread over that muscle, along the lower border of the last rib. Near the vertebral column it sends a small offset downwards to the first lumbar nerve, and at the lateral border of the quadratus lumborum it pierces the aponeurosis of the transversus abdominis, and then passes forwards in the abdominal wall between that muscle and the internal oblique. Its course and distribution in the wall of the abdomen have already been described (p. 217).

Arteriæ Lumbales.—The lumbar arteries have been traced to the medial border of the psoas major. Thence they pass backwards, medial to the psoas major, to the intervals between the transverse processes of the vertebræ, where each gives off a dorsal branch.

Each *dorsal branch* runs backwards, between the adjacent transverse processes, and after giving a *spinal branch* which enters the vertebral canal through the intervertebral foramen, it ends in the muscles and integument of the back.

After giving off their *dorsal* branches, the trunks of the arteries, with the exception of the last, proceed laterally behind the psoas and the quadratus lumborum, and are then directed forwards between the internal oblique and transversus muscles, where they anastomose, *superiorly*, with the intercostal arteries, *inferiorly*, with the deep circumflex iliac and ilio-lumbar arteries, and *anteriorly*, with the branches of the superior and inferior epigastric arteries. The last lumbar artery, as a rule, passes in front of the quadratus lumborum.

Venæ Lumbales.—The lumbar veins accompany the corresponding arteries. The first, and sometimes the second,

on the right side join the vena azygos, and the corresponding veins on the left side, end in the hemiazygos vein; the others pour their blood into the inferior vena cava. The lower veins of the left side pass behind the aorta. The lumbar veins of each side are linked together, in front of the transverse processes of the vertebræ, by anastomosing channels which form a continuous longitudinal vessel, called the *ascending lumbar vein.* The upper end of the ascending lumbar vein is connected with the corresponding azygos vein.

Subcostal Artery.—At this stage of the dissection the subcostal artery, the last parietal branch of the thoracic aorta, will be seen crossing the upper part of the quadratus lumborum, in company with the last thoracic nerve. It lies in series with the abdominal branches of the lumbar arteries and it accompanies the last thoracic nerve.

Dissection.—The lower limbs having, by this time, been removed from the trunk, the pelvis also may be detached. Place a ligature around the aorta and inferior vena cava at the level of the bifurcation of the former, and divide them immediately above that point. Then carry the knife through the interverte-bral fibro-cartilage which intervenes between the third and fourth lumbar vertebræ, and, having cut the nerves and soft parts, complete the separation of the pelvis from the remainder of the trunk by means of a saw.

PELVIS.

The pelvis, using the term in its widest sense, is the region bounded *posteriorly* by the sacrum and coccyx, and *laterally* and *anteriorly* by the hip bones. The bony wall is deficient, on each side posteriorly, between the sacrum and coccyx behind and the hip bone in front. The interval on each side is partially filled in by the ligamentum sacro-tuberosum (O.T. *great sacro-sciatic ligament*) and the ligamentum sacro-spinosum (O.T. *small sacro-sciatic ligament*), which divide it into the greater and lesser sciatic foramina. Anteriorly, on each side, the bony wall is broken by the obturator foramen, which is closed by the obturator membrane; and directly in front there is a gap bounded by the pubic arch and occupied by the urogenital diaphragm and its fasciæ (O.T. *triangular ligament*).

The area thus enclosed is separated into an upper and

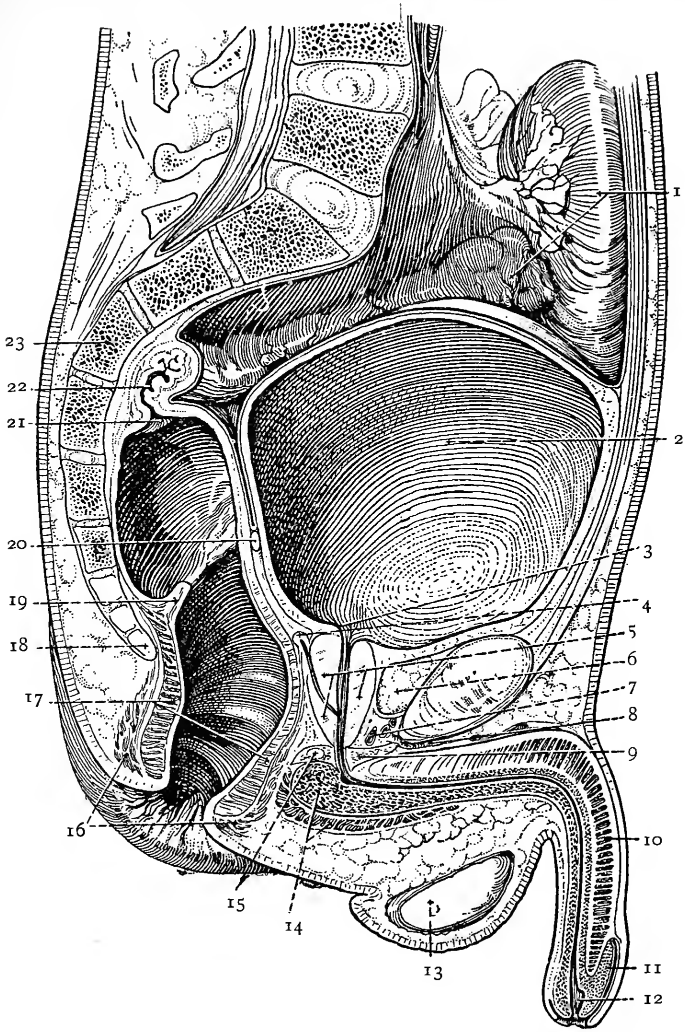

FIG. 189.—Sagittal section of the Pelvis of a young Male Adult with distended Bladder and Rectum.

1. Pelvic colon.
2. Urinary bladder.
3. Uvula of bladder.
4. Seminal vesicle.
5. Prostate.
6. Retro-pubic fat.
7. Pudendal plexus of veins.
8. Dorsal vein of penis.
9. Sphincter urethræ around membranous part of urethra.
10. Corpus cavernosum penis.
11. Glans penis.
12. Fossa navicularis of urethra.
13. Testis.
14. Bulb of urethra and bulbo-cavernosus muscle.
15. Bulbo-urethral gland.
16. External sphincter.
17. Internal sphincter.
18. 4th piece of coccyx.
19. 2nd transverse rectal fold.
20. Ductus deferens.
21. 1st transverse rectal fold.
22. Commencement of rectum.
23. 3rd sacral vertebra.

a lower part by an imaginary plane, the plane of the pelvis

brim. The margin of this plane is the linea terminalis which is separable into sacral, iliac, and pubic portions. The sacral part of the linea terminalis is formed by the upper border of the anterior surface of the first sacral vertebra and the anterior margins of the ulæ of the sacrum. The ilio-pectineal lines of the iliac and pubic bones and the crest of the pubic bones constitute the iliac and pubic portions. The part above the plane is the pelvis major (O.T. *false pelvis*), which has already been studied as part of the abdomen. The part below the plane is the pelvis minor (O.T. *true pelvis*). The inner aspect of the wall of the pelvis minor is partially covered by the following muscles. *Posteriorly*, on the front of the sacrum, are the two *piriformes muscles*. *Laterally*, on the inner surface of each hip bone, is the *obturator internus muscle*. *Anteriorly* is the uro-genital diaphragm, formed by the deep transverse perineal muscles and the *sphincter urethræ membranaceæ*. The inner surfaces of the muscles mentioned and the intervening skeletal structures are covered by a continuous layer of fascia, the *parietal pelvic fascia*. The wall of the pelvis minor may, therefore, be regarded as consisting of three strata, viz.—1. A bony stratum. 2. A muscular stratum. 3. A membranous stratum.

The pelvis minor is separated into an upper part and a lower part by the *pelvic diaphragm* and the fascia covering it. The pelvic diaphragm is formed by the two *levatores ani* and the two *coccygei muscles*. In the following account the upper part will be spoken of as the *pelvis minor*. The lower part has already been called the *perineum*.

The pelvis minor, as thus defined, is the smaller, basin-shaped, lower part of the abdominal cavity above the pelvic diaphragm. It communicates with the upper portion through a somewhat constricted aperture, the superior aperture of the pelvis minor.

The contents of the pelvic cavity differ in the two sexes; in both, however, the bladder occupies the anterior part of the space, and the rectum and pelvic colon the posterior part. The difference is to be found in the generative organs and their blood-vessels. It is necessary, therefore, to describe the male and the female pelvis minor separately.

Male Pelvis Minor.

The male pelvis minor contains the following structures :—

Viscera.	The rectum and the pelvic colon.[1] The urinary bladder, with the lower portions of the ureters, the prostate, and the prostatic part of the urethra.[1] The ductus deferentes and the vesiculæ seminales.[1]
Blood-Vessels.	The hypogastric vessels and their branches and tributaries. The superior hæmorrhoidal vessels. Venous plexuses associated with the viscera.
Nerves.	The pelvic plexuses of the sympathetic system and their offshoots. The obturator nerves.
Other Structures.	The extraperitoneal fat. The pelvic part of the peritoneum.

The following structures lie between the pelvic fascia and the bony and muscular strata of the pelvic wall :—

Blood-Vessels.	The middle sacral vessels. The parietal branches of the hypogastric vessels, after they have pierced the fascia.
Nerves.	The sacro-pudendal and coccygeal plexuses of nerves. The pelvic parts of the sympathetic trunks.

General Position of the Viscera.—The *pelvic colon* and the *rectum* occupy the posterior part of the cavity, the colon extending in flexuous curves from the left margin of the superior aperture of the pelvis minor to the middle of the third piece of the sacrum, where it becomes the rectum. The rectum follows the concavity of the sacrum and coccyx, and runs forwards to the base of the urinary bladder (Figs. 189, 190). The *urinary bladder* lies in the anterior part of the cavity, behind the pubic bones, and in front of the rectum. The *seminal vesicles* lie in a plane between the bladder and the rectum, and the ductus deferentes having crossed the brim, behind the origins of the inferior epigastric arteries, run downwards and backwards, and then turn medially, across the ureters, to gain the base of the bladder, at the medial sides of the seminal vesicles. The pelvic portions of the ureters can be seen descending, outside the peritoneum, along the fronts of the hypogastric arteries, and turning medially, below the

[1] Strictly speaking, the urinary bladder, the prostate, the seminal vesicles, and the lower parts of the rectum, ductus deferentes and ureters are not in the pelvis, for they are embedded in the pelvic fascia and, therefore, lie in the pelvic wall.

ductus deferentes, towards the base of the bladder. The prostate lies below the bladder and encloses the prostatic part of the urethra (Fig. 190).

The Pelvic Peritoneum.—The peritoneum passes into the pelvis minor through the superior aperture, and gives partial or complete coverings to various viscera. It covers the upper surface of the bladder, and passes from the lateral borders of that surface to the side walls of the pelvic cavity, as the *lateral*

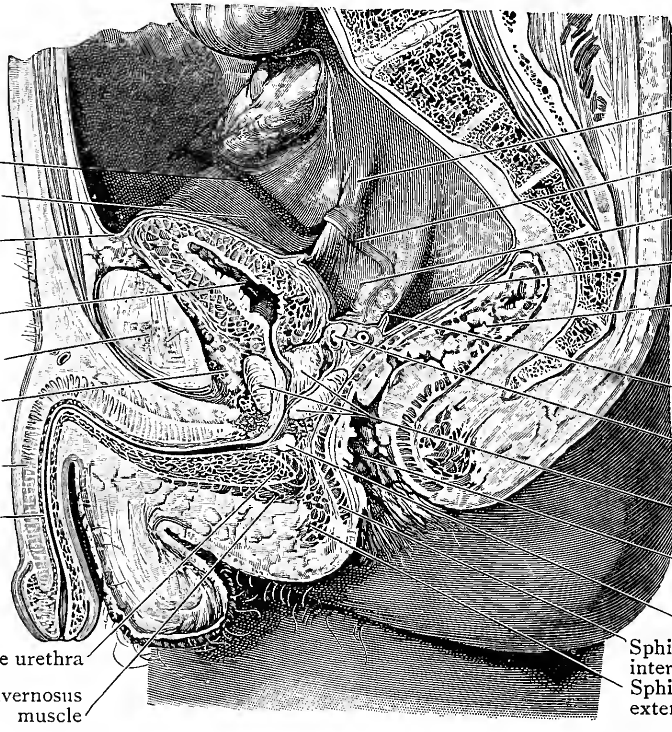

FIG. 190.—Median section through the Male Pelvis. The bladder, which is empty, does not present the usual form.

false ligaments of the bladder. Turning over the posterior border of the upper surface of the bladder, it descends, for a slight distance, on the fundus or base of the viscus, and then, if the bladder is empty, it projects backwards as a semilunar ledge or fold, called the *sacro-genital fold* (Fig. 191.) In the middle portion of that fold the seminal vesicles are enclosed and parts of the ductus deferentes. The lateral borders of the fold curve backwards to the sacrum, passing at some little distance from the sides of the rectum. From the lower

surface of the sacro-genital fold the peritoneum passes to the front of the rectum, on which it is reflected upwards to the pelvic colon. Below the line of reflection from the sacro-genital fold there is a part of the rectum entirely devoid of peritoneal covering. The part immediately above that is covered only in front, but at a higher level the front and the sides also are covered; and when the pelvic colon is reached the peritoneum entirely surrounds that part of the gut and attaches it to the posterior wall of the pelvis by a fold or mesentery, called the *pelvic meso-colon.* The hollow or pouch between the sacro-genital fold in front and the rectum behind is the *recto-vesical* or *recto-genital pouch.*

The Peritoneal Fossæ.—As the peritoneum follows the contours of the more projecting viscera, three hollows or secondary pouches are formed on each side: an *anterior* or *paravesical*, a *middle* or *genital*, and a *posterior* or *pararectal.* The paravesical fossa is bounded medially by the bladder, laterally by the pelvic wall, and posteriorly by a ridge of peritoneum, caused by the ureter, which runs backwards and laterally from the postero-lateral angle of the upper surface of the bladder towards the hypogastric artery. Beneath the floor of the paravesical fossa the ductus deferens runs medially towards the genital fossa. The genital fossa lies between the ureteral ridge and the margin of the sacro-genital fold; and the pararectal fossa is between the sacro-genital fold and the side of the rectum. The two pararectal fossæ are continuous with each other across the front of the rectum and form together the recto-vesical pouch. When the rectum is distended the peritoneum of the pararectal fossæ is lifted up to cover the expanding wall of the viscus, the pararectal fossæ are obliterated, and the posterior ends of the sacro-genital folds terminate on, or in close relation with, the wall of the rectum. When the bladder is distended the middle part of the sacro-genital fold is also opened out to help to cover the upper part of the fundus of the bladder, but the lateral parts remain. If, however, the bladder and rectum are simultaneously distended the lateral parts of the sacro-genital fold pass from the back of the bladder either to the rectum or to the posterior wall of the pelvis close to the rectum, and under those conditions the folds in question were formerly described as the *recto-vesical folds* or *posterior false ligaments* of the bladder.

The False Ligaments of the Urinary Bladder.—The false

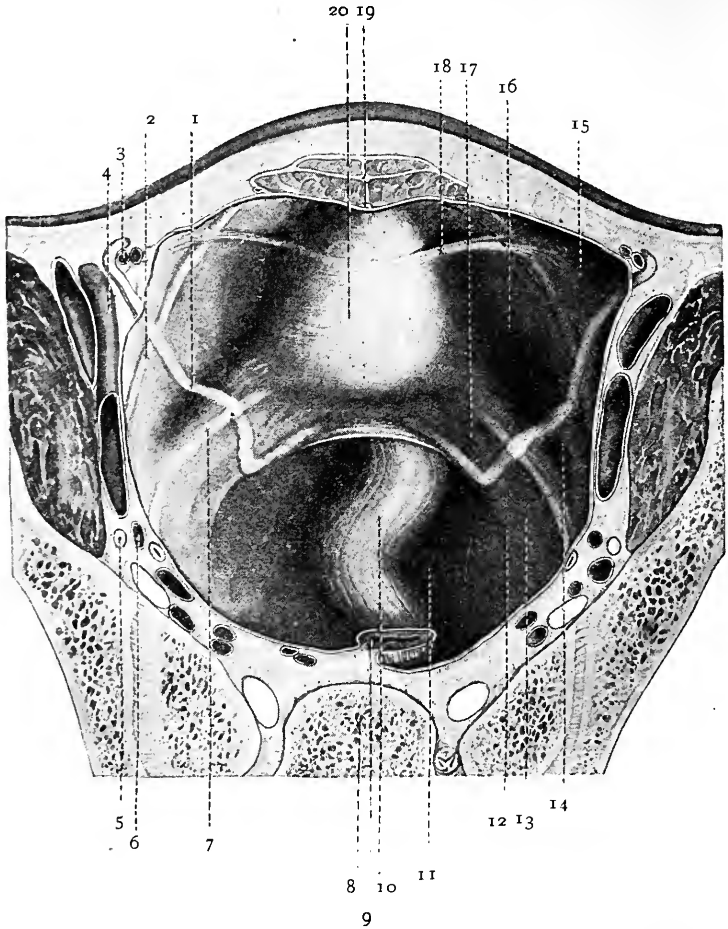

FIG. 191.—The Peritoneum of the Cavity of the Pelvis Minor.

The upper part of the posterior wall of the pelvis minor has been removed to show more clearly the disposition of the peritoneum within its cavity. (Dixon and Birmingham.)

1. Ductus deferens.
2. Umbilical artery.
3. Inferior epigastric artery.
4. External iliac vessels.
5. Obturator nerve.
6. Umbilical artery.
7. Ureter.
8. Third sacral vertebra.
9. Lower part of pelvic meso-colon.
10. Rectum.
11. Pararectal fossa.
12. Sacro-genital fold.
13. Lateral portion of middle fossa.
14. Genital fossa.
15. Lateral inguinal fovea.
16. Paravesical fossa.
17. Median portion of middle fossa.
18. Plica vesicalis transversa.
19. Urachus.
20. Bladder.

ligaments of the bladder are parts of the pelvic peritoneum. When the bladder is empty, a fold called the *plica umbilicalis*

media (O.T. *superior false ligament*) extends from the anterior end of its upper surface, *i.e.*, the *apex* of the bladder, to the posterior surface of the anterior abdominal wall. It is caused by the projection of the *ligamentum umbilicale medium*, which consists of the urachus, a fibrous remnant of part of the cloaca, and it separates the paravesical and supravesical fossæ from the corresponding fossæ of the opposite side. The peritoneum extending from each lateral border of the upper surface of the bladder to the side wall of the pelvis constitutes a *lateral false ligament*, and forms the floor of the corresponding paravesical fossa. Not uncommonly each lateral false ligament and the peritoneum on the upper surface of the bladder are divided into anterior and posterior portions by a transverse fold, the *plica vesicalis transversa*, which crosses from one side of the superior aperture of the pelvis minor to the other. It is questionable if the term *posterior false ligament* should be retained; it is still applied, however, to the remnants of the sacro-genital folds which extend from the back of the distended bladder to the sides of the distended rectum, or to the front of the sacrum.

Dissection from above.—All the peritoneum above the level of the pelvic brim should now be removed, care being taken not to injure or displace the ureter or the ductus deferens. The dissector should then stitch the ureter to the artery it crosses at the brim, common or external iliac as the case may be. He must also stitch the ductus deferens to the external iliac artery, close to the origin of the inferior epigastric branch. That being done, he must carefully detach the peritoneum from the extra-peritoneal fat, separating any adhesions with the knife. The separation should be commenced at the brim, and be carried medially until the root of the pelvic meso-colon, the side of the rectum, and the lateral border of the upper surface of the bladder are reached.

When that stage has been attained on both sides, the dissector should displace the bladder backwards, and pass his finger down between the viscus and the symphysis, through the soft extraperitoneal fat, till it meets a resisting membrane. The membrane is the visceral layer of the pelvic fascia or upper layer of the fascia of the pelvic diaphragm. By his sense of touch the dissector will recognise not only that it is attached to the lower part of the posterior surface of the symphysis, but also that two thickened bands of its substance extend backwards, one on each side of the median plane, from the back of the symphysis to the anterior border of the bladder. The bands are the *anterior true ligaments* of the bladder or the medial *pubo-prostatic ligaments*, the latter name indicating that, in the male, they are placed above the prostate. Having satisfied himself regarding the pubo-prostatic ligaments, the dissector should carry his finger backwards, between the bladder and the

wall of the pelvis, displacing the soft fat, until he touches the ureter. The region which he will thus investigate is the lower and anterior part of a large area, known as the *cave of Retzius*, in which the extraperitoneal fat has very slight attachment either to the peritoneum or to the pelvic fascia, and in which, therefore, it is very easily displaced. The area extends from the hypogastric artery of one side round the front of the bladder to the hypogastric artery of the opposite side, downwards to the visceral layer of the pelvic fascia, and upwards, between the umbilical (O.T. obliterated hypogastric) arteries, to the umbilicus. The facility with which he displaces the fatty tissue should demonstrate to the dissector how easy, in that area, will be the spread of urine effused from a ruptured bladder, or of blood running from a divided artery, or of effusions due to inflammatory conditions.

The dissector must now remove the extraperitoneal fat first from the ductus deferens, then from the region of the ureter, and afterwards from the hypogastric vessels and their branches and tributaries. Whilst that is being done, the obturator nerve will be brought into view to the lateral side of the ureter, and below the level of the umbilical artery. Whilst removing the fat and displaying the structures embedded in its substance, the dissector must be careful not to injure either the parietal or the visceral pelvic fascia. He will find that some of the branches of the hypogastric artery pierce the parietal fascia as they leave the pelvis, and that the visceral branches, the rectum, the ureter, and the ductus deferens, pass into the substance of the visceral layer.

When the dissection is completed the student should note the relative positions of the structures he has exposed. The ductus deferens will be seen passing downwards and backwards, on the side wall of the pelvis, till it meets the ureter, which is passing downwards, from the junction of the lateral and posterior walls of the cavity and along the front of the hypogastric artery. Before they meet, both the ductus deferens and the ureter turn medially and, medial to the point of crossing, they both enter the visceral layer of the pelvic fascia. Behind the ureter is the hypogastric artery, dividing into its anterior and posterior divisions. Running forwards on the lateral side of the ureter and the ductus deferens are the umbilical, the obturator, the middle and inferior vesical, and, not uncommonly, the middle hæmorrhoidal branches of the anterior division of the hypogastric artery. Springing from the umbilical artery are one or more superior vesical arteries, whilst below the umbilical artery and above the obturator artery is the obturator nerve, which pierces the parietal fascia at the back of the pelvis and runs forwards, above the corresponding artery and vein, to the

obturator canal. Behind the ureter the lateral sacral branches and the gluteal continuation of the posterior division of the hypogastric artery will be seen piercing the pelvic fascia, and when the posterior division of the artery is displaced medially its ilio-lumbar branch will be found. The

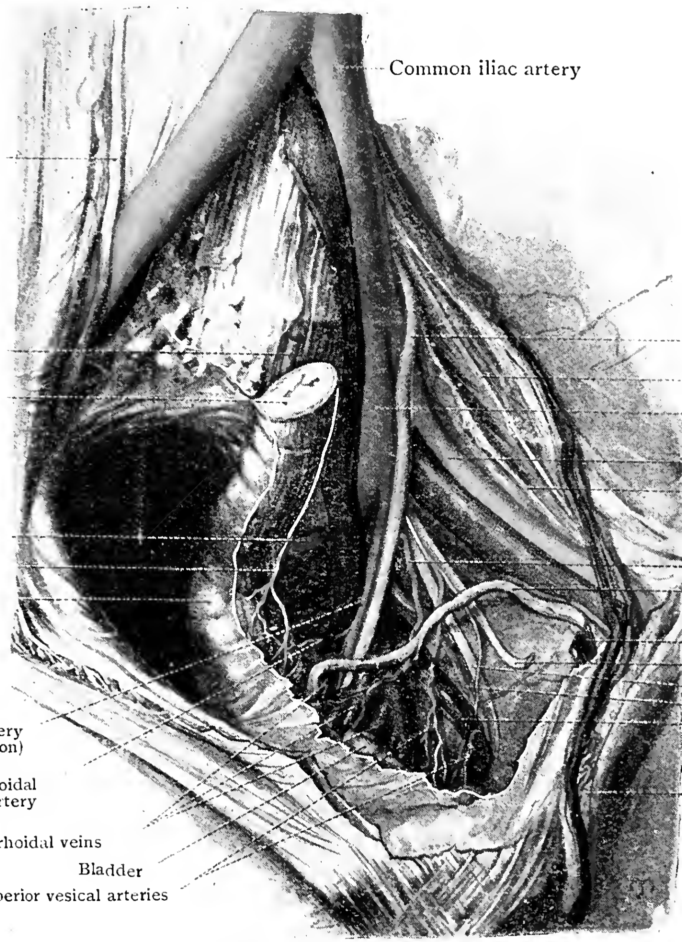

FIG. 192.—The Structures exposed in the left half of the Pelvis Minor by the removal of the peritoneum and extraperitoneal fat.

hypogastric vein lies along the posterior border of the artery, and those of its tributaries which correspond to the anterior branches of the artery pass, usually, to the medial side of the anterior division of the artery on their way to the main vein. There is no vein with the umbilical artery or its superior vesical branch. As a rule only one vein accompanies

the obturator artery, but the inferior vesical and middle hæmorrhoidal veins are usually numerous, and, as they pass to their termination, they ensheathe the lower part of the ureter. The lateral sacral and gluteal veins end in the hypogastric vein, but the ilio-lumbar vein is, usually, a tributary of the common iliac vein.

Endo-Pelvic Fascia.—When the dissector has studied the general position of the structures exposed by the removal of the peritoneum and the extraperitoneal fat of the pelvis, he should turn his attention to the endo-pelvic fascia. It consists of two main parts: a parietal part, which forms part of the pelvic wall, and a diaphragmatic part, which covers the upper and lower surfaces of the pelvic diaphragm. The upper fascia of the diaphragm is known as the *visceral layer* of the pelvic fascia, because it enters into intimate relationship with the pelvic viscera. The visceral part of the pelvic fascia stretches across the cavity, from side to side and from front to back, and helps to separate the perineum from the remainder of the pelvis.

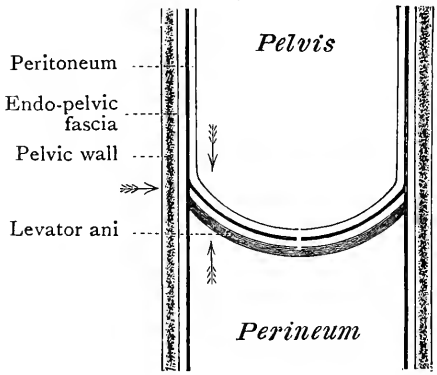

FIG. 193.—Diagram of the Pelvic Wall and Pelvic Floor.

If the upper part of the parietal layer is examined it will be found that it is continuous at the pelvic brim with the fascia on the psoas major muscle, from which it descends to the level of a line drawn from the lower part of the back of the body of the pubis to the spine of the ischium. At that level the visceral layer springs from the parietal layer, its origin serving to separate the latter into lower and upper parts. If the upper part of the parietal portion is traced backwards it will be found to extend round the lateral side of the hypogastric vessels and across the front of the sacrum, behind the pelvic meso-colon and the rectum, to the opposite side. If it is traced forwards, a short distance below the brim, it will be found to blend with the periosteum on the back of the superior ramus of the pubis, along an oblique line which descends from the junction

of the middle third with the lower third of the external iliac artery to the upper margin of the obturator foramen. Below the superior ramus of the pubis it forms a distinct thickened border which bridges across the upper part of the obturator foramen, and forms the lower boundary of the commencement of the obturator canal, by which the obturator artery and nerve leave the pelvis. To the medial side of the obturator foramen the parietal fascia blends with the

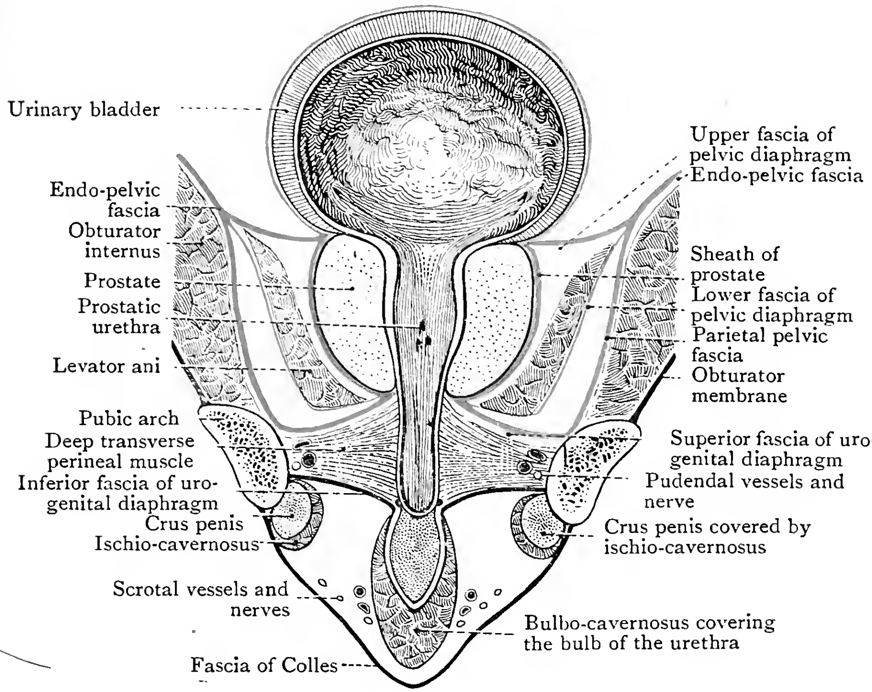

FIG. 194.—Vertical transverse section through the Bladder, Prostate, and Pubic Arch to show the arrangement of the Endo-pelvic Fascia: schematic. The endo-pelvic fascia is depicted in red.

periosteum on the back of the body of the pubis, along a line which descends towards the apex of the pubic arch and passes below the line of attachment of the visceral layer. The parietal layer is deficient, therefore, in the region of the upper part of the anterior wall of the pelvis, and as its anterior margin blends with the periosteum on the pubis any effusion lying external to the fascia will be prevented from extending forwards to the anterior part of the pelvis.

The lower part of the parietal layer should next be

examined. In the dissection of the perineum the student saw that the lower part of the parietal pelvic fascia lined the lateral wall of the ischio-rectal fossa, and that it blended, immediately below the origin of the levator ani, with the lower layer of the fascia of the pelvic diaphragm, which covers the lower surfaces of the levator ani and the coccygeus (anal fascia). He saw also that, in the anterior part of the perineum, the parietal fascia extended medially, as the *superior fascia of the urogenital diaphragm*, from the margin of the pubic arch to the side of the urethra, where it not only blended with the fascia coming from the opposite side, but

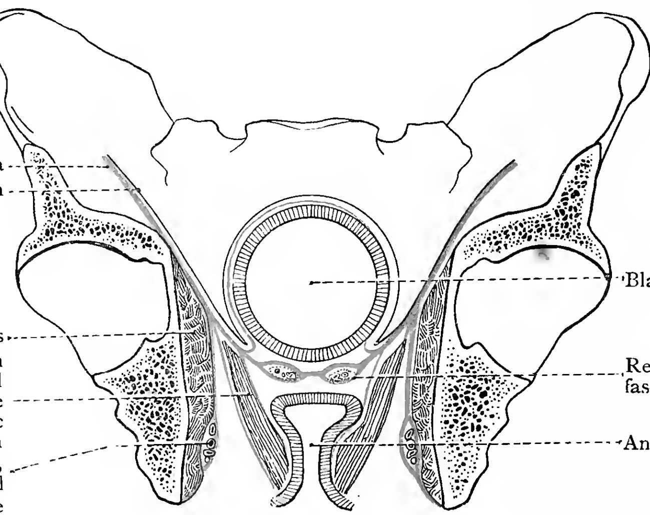

FIG. 195.—Diagram of the Endo-pelvic Fascia. The pelvis is divided in a frontal plane and the pelvic fascia is represented in red.

also became continuous, round the anterior border of the levator ani, with the fascia on the upper surface of that muscle, that is, with the visceral layer of the pelvic fascia.

To display the details of the visceral layer of the fascia the final stages of the dissection of the perineum must now be completed.

Dissection.—The dissector must carefully define the anterior borders of the levatores ani muscles, and then he must cut boldly through the centre of the perineum between the bulb and the anal orifice until he reaches the fascial interval between the posterior surface of the prostate and the front of the lower part of the rectum. When the interval is reached the knife may be discarded and the forefinger introduced into the space

and carried from side to side. In that way it is possible to demonstrate that the visceral layer of the pelvic fascia, as it descends on the levator ani, divides into a lower layer, which passes behind the rectum, and a layer which passes between the rectum and the prostate—the recto-vesical layer (Fig. 195).

The right levator ani must now be divided, from before backwards, about midway between its origin from the parietal fascia and its insertion into the wall of the anal passage, care being taken to avoid injury to the fascia on its upper surface. The lower part of the muscle should be followed to its insertion into the wall of the anal canal, and the mode of insertion between the internal and the external sphincters noted. The upper part should be turned laterally and the fingers of the left hand passed along its upper surface till its origin from the fascia is reached. When that is done the dissector will find that the only structure which separates his fingers from the cavity of the pelvis is the upper layer of the fascia of the pelvic diaphragm (*visceral layer of the pelvic fascia*), which extends from the parietal fascia, at the level of the origin of the levator ani, and passes medially to the walls of the viscera, which it ensheathes. If the dissector will now place the fingers of one hand on the upper surface of the visceral fascia and those of the other hand on the lower surface, and then carry both hands medially, he will find that the one hand passes on to the upper surface of the bladder and the other behind the rectum. He will thus demonstrate that as the visceral fascia crosses the pelvis from side to side it separates into an upper or vesical layer and a lower or rectal layer. The third or recto-vesical layer, which covers the posterior surface of the prostate, and separates the gland from the rectum, has already been demonstrated. The recto-vesical layer must now be incised, in the median plane, on the posterior surface of the prostate and each half must be turned laterally. As the borders of the prostate are approached a plexus of veins will be exposed on each side, and immediately beyond the plexus the recto-vesical layer of the fascia will be found to blend with the vesical layer, which passes over the upper surface of the prostate. The ductus deferentes and the seminal vesicles will be exposed when the reflection of the recto-vesical layer is carried backwards beyond the prostate (Fig. 196).

The True Ligaments of the Bladder.—There are five so-called true ligaments of the bladder: two *lateral*, the lateral pubo-vesical ligaments; two *anterior*, the medial pubo-vesical ligaments (pubo-prostatic in the male); and one *superior*. The lateral are the lateral parts of the vesical layer of pelvic fascia. The anterior are two thickenings of the same layer, one on each side of the median plane, in front of the bladder; they contain smooth muscle fibres which pass from the bladder to the back of the pubic bones at the margins of the symphysis. The superior, the lig. umbilicale medium, is the urachus.

During the various stages of this dissection the student

should repeatedly convince himself, by introducing the index finger of his right hand into the rectum and that of his left hand into the pelvis, that he can quite easily define the outlines of the prostate and the seminal vesicles by a process of palpation; and when he has completed the dissection he should note that he has demonstrated that the visceral layer of the pelvic fascia, which is single laterally, is cleft medially

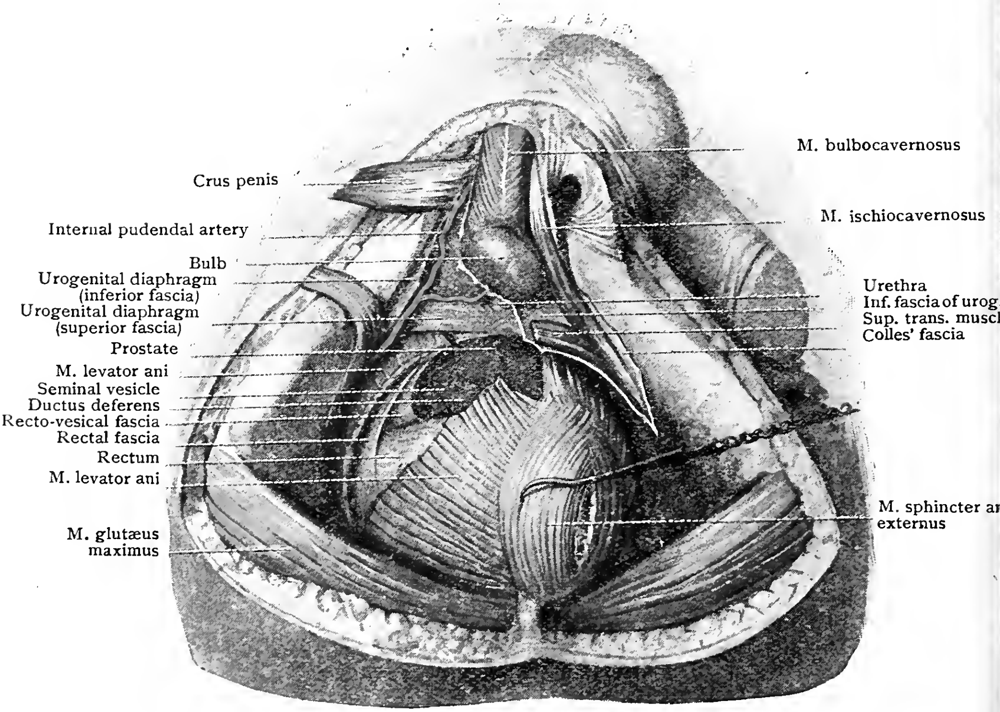

FIG. 196.—Dissection to expose the Prostate from the Perineum.

into three lamellæ by the interposition of the rectum between a middle and a lower layer, and the interposition of the bladder and the prostate between the middle and an upper layer. There are two compartments, therefore, in the substance of the fascia: a lower or posterior, which contains the rectum; and an upper or anterior, in which lie the bladder, the prostate, the seminal vesicles, and the lower parts of the ductus deferentes.

Dissection.—The suspensory ligament of the penis, which has already been defined (see p. 245), must now be detached from the front of the symphysis. The left crus of the penis has already been separated, and the right crus should now be cut away from

the margin of the pubic arch and the inferior fascia of the urogenital diaphragm, care being taken to avoid injuring the latter. As the penis is turned down, the median and single deep dorsal vein will be seen to pass backwards, between the arcuate ligament and the upper border of the transverse ligament of the pelvis (which is the thickened upper border of the fasciæ of the urogenital diaphragm), into the pelvis, where it will be followed at a later stage. The dorsal artery and the dorsal nerve of the penis pierce the inferior fascia of the urogenital diaphragm near the anterior part of the margin of the pubic arch, and the deep

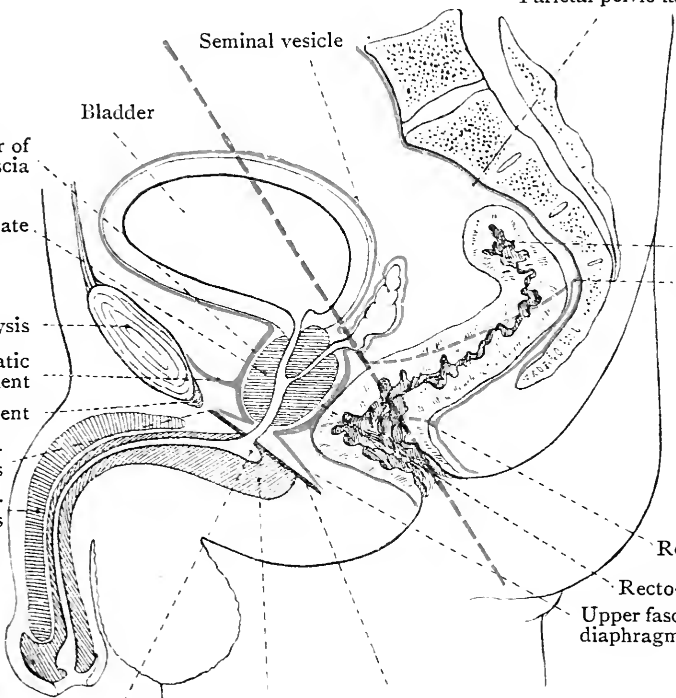

FIG. 197.—Diagram of the Pelvic Fascia as seen in a sagittal section of the Pelvis. Pelvic fascia represented in red.

artery of the penis frequently passes through the same fascia immediately to the lateral side of the nerve (Fig. 198). The proximal parts of the structures mentioned have already been seen in the dissection of the perineum. The bulb of the urethra should now be carefully detached from the anterior part of the inferior fascia of the urogenital diaphragm and turned downwards until the urethra is brought into view. The urethra pierces the anterior part of the fascia in the median plane and passes at once into the bulb.

The muscles and fascia must now be detached from the anterior surfaces and upper borders of the bodies of the pubic

bones, and from the upper parts of the pubic rami. Then the bones must be cut through, with the saw, on each side, along a line running from below the attachment of the arcuate ligament up to the lateral side of the pubic tubercle (see Fig. 198). By the saw-cuts a considerable part of the anterior wall of the pelvis is isolated, and it can be removed when the vesical layer of the

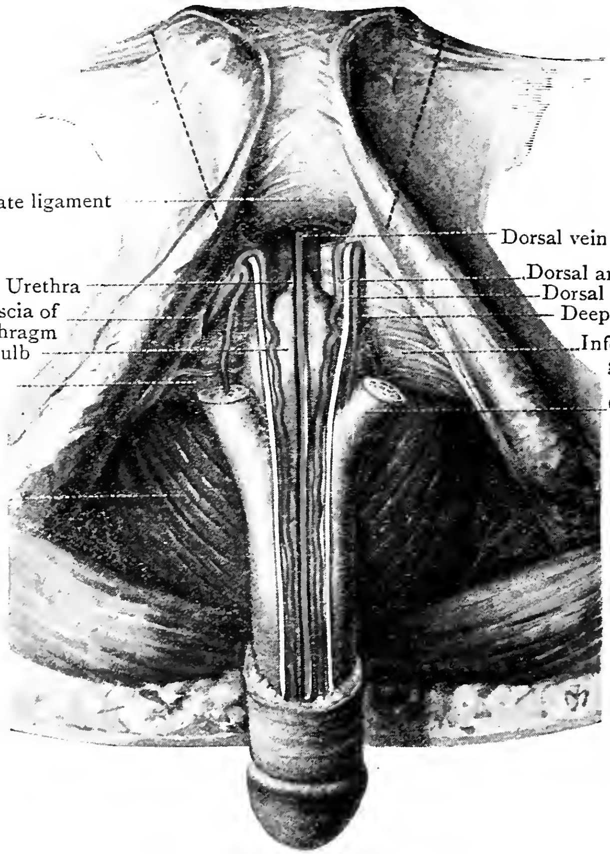

FIG. 198.—Dissection to show the Dorsal Vessels and Nerves of the Penis and their relations to the fasciæ of the Urogenital Diaphragm. The upper part of the deep transverse perineal muscle has been left between the two fasciæ. The lower part has been removed to expose the superior fascia. The lines of the saw-cuts made in the dissection are indicated on the bones by the dotted lines.

endo-pelvic fascia has been detached from its posterior surface. Having been removed, it must be kept for the examination of the inter-pubic joint. Whilst the bone is being removed care must be taken to avoid injuring the dorsal vein of the penis.

After the bone is removed the dissector will see the anterior border of the vesical layer of the pelvic fascia, which has been detached from the back of the pubis. In the fascia he will readily recognise the thickened bands of the pubo-prostatic

ligaments. The vesical layer must now be divided in the median plane and turned laterally to each side. Whilst that is being done it will be noticed that, above the prostate, the vesical layer is gradually lost on the anterior border and infero-lateral surfaces of the bladder (Fig. 199). When the fascia has been turned laterally to its junction with the recto-vesical layer, already displayed from below, the dorsal vein of the penis must be followed backwards. It divides, immediately after entering the pelvis, beneath the vesical layer of fascia, into right and left branches which join the corresponding parts of the pudendal (O.T. *prostatic*) venous plexus.

The dissector should notice that, by the removal of the bone in the region of the symphysis, he has exposed not only the structures already noted, but also the whole of the anterior border of the bladder and parts of its infero-lateral surfaces. If he now replaces the pelvic peritoneum, he will find that it has no relation to the border and surfaces mentioned; they lie entirely below the level of the peritoneum. They form the posterior boundary of the lower part of the cave of Retzius, and lie in relation with the anterior and antero-lateral parts of the pelvic wall, from which they are separated by the extraperitoneal fatty tissue which was removed at an earlier stage of the dissection. The dissector has now seen three surfaces of the bladder—the superior surface, covered with peritoneum, and the two infero-lateral surfaces. The bladder possesses also a fourth surface, the fundus or base, which lies in relation with the deferent ducts, the seminal vesicles, and to a less extent with the lower part of the anterior wall of the rectum. That surface and the interior of the bladder should now be investigated.

Dissection.—Enter the knife through the anterior border of the bladder, a little below its upper extremity, and carry it backwards first on one side and then on the other, just below the upper border of each infero-lateral surface. When the incisions have been made, push the upper surface of the bladder backwards and press the infero-lateral surfaces downwards and forwards. An excellent view of the interior will thus be obtained, and, when its surface has been sponged, the mucous lining and the orifices may be examined, and the relations of the base may be investigated. If it is necessary, the anterior border may be divided vertically from the apex of the bladder to the upper border of the prostate.

Interior of Bladder.—The mucous membrane is rugose, when the bladder is empty, over the whole of the inner surface, except a small triangular area on the basal wall (Fig. 200). The rugosity is due to the loose manner in which the

membrane is bound to the muscular coat by the layer of submucous tissue. When the bladder is distended the folds are effaced, and the mucous lining becomes smooth throughout.

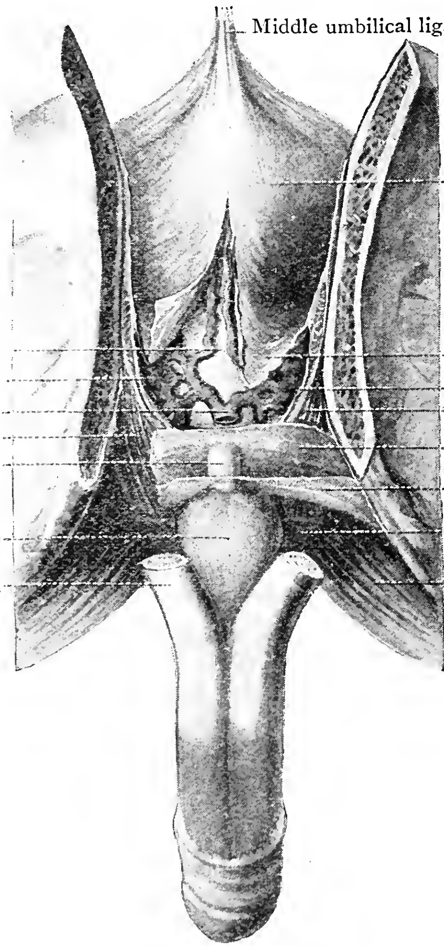

FIG. 199.—Dissection of the Bladder, the Endo-Pelvic Fascia, and the Prostate from the front. The sphincter of the membranous part of the urethra has been removed from between the two layers of the fascia of the urogenital diaphragm.

Orifices and Trigone of the Bladder.—There are three orifices in the bladder wall—two orifices of inlet, the orifices of the ureters; and one orifice of outlet, the orifice of the urethra. They are situated at the three angles of the triangular smooth area of the mucous membrane which is known as the *Trigonum Vesicæ* (*Trigone of the Bladder*). In

that area the mucous membrane is always smooth, whether the bladder is distended or empty, on account of the close connection which exists between the mucous and muscular coats. At the inferior angle of the area is the internal urethral orifice, semilunar or V-shaped in outline, with a

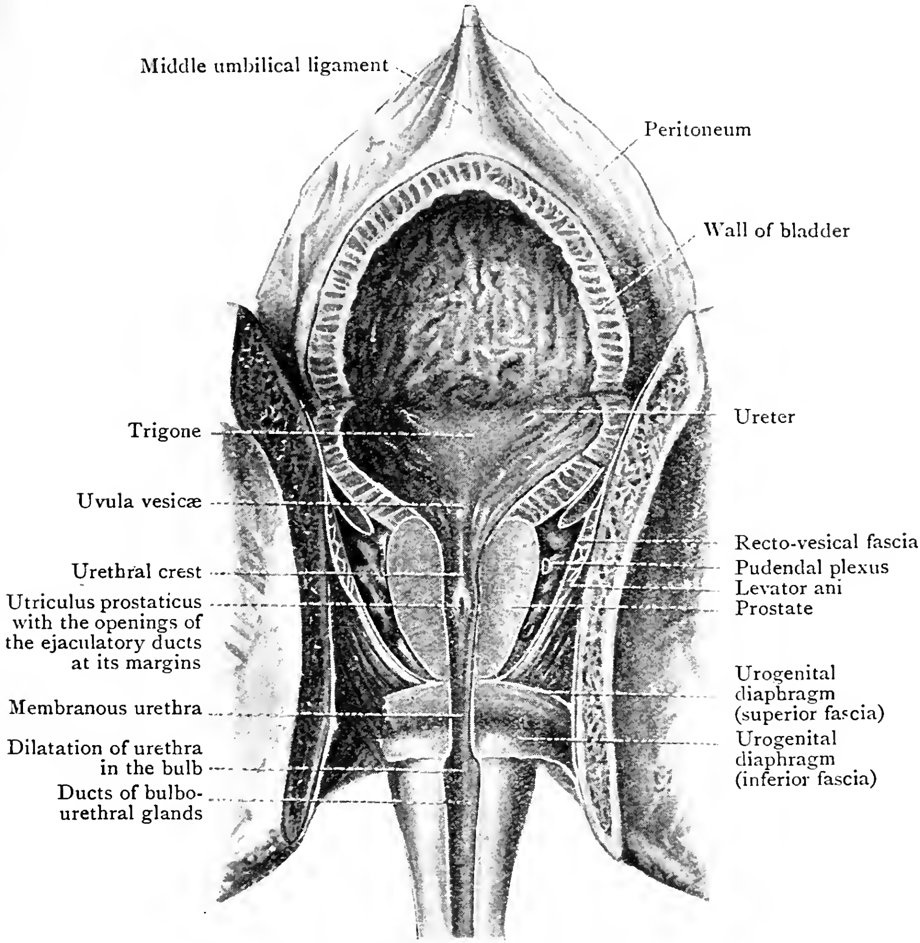

FIG. 200.—Dissection of Bladder and Urethra from the front. The sphincter of the membranous part of the urethra has been removed from between the two fasciæ of the urogenital diaphragm.

slightly elevated posterior lip, which is known as the *uvula* of the bladder (Figs. 189 and 200). The elevation indicates the position of the middle lobe of the prostate gland below. When the bladder is empty and contracted a number of radial ridges of mucous membrane diverge from the margins of the orifice.

The ureteral orifices lie at the superior angles of the trigone. They are small semilunar slits, and are frequently connected together by a transverse bar of mucous membrane (*torus vesicalis*) which covers a bar of muscle. Not uncommonly a ridge of mucous membrane covering a muscular band will be found connecting each ureter with the urethra. Probes should be passed along the ureters to demonstrate the obliquity with which the ducts pass through the bladder wall. It will be found that each ureter runs through the substance of the bladder wall for about 20 mm. (three-quarters of an inch). This arrangement serves the purpose of a valve which allows urine to pass easily into the bladder but tends to prevent its backward flow. When the bladder is distended the openings of the ureters are about 35 mm. (an inch and a half) apart, and about the same distance from the orifice of the urethra, but when the viscus is empty and contracted the distance between the orifices is reduced to about 25 mm. (one inch) in each case.

The dissector should now investigate the relations of the fundus of the bladder by palpation. Keeping one index finger in the bladder and passing the other into the rectum, he will find that he can distinguish the prostate below and around the internal urethral orifice. Above the level of the prostate he can feel the thick walls of the deferent ducts, one on each side of the median plane, and more laterally he will recognise the convoluted coils of the seminal vesicles. If he passes his finger upwards, along the median plane, he will find that the deferent ducts diverge, and that between them the rectum and bladder lie in contact. The area in which that contact occurs corresponds with the posterior part of the trigone, and varies considerably in size. When the bladder is empty the area is small or absent; but it increases considerably when the bladder is distended.

Dissection.—When the dissector has satisfied himself regarding the relations of the base of the bladder and the possibility of easily distinguishing them with the finger through the rectal wall, he should introduce a blunt-pointed knife, or a pair of scissors, through the internal urethral orifice into the urethra, and lay the canal open by dividing its dorsal wall from the bladder to the end of the penis.

Urethra Virilis.—The male urethra is the canal through which the urine, the semen, and the secretions of the seminal vesicles, the prostate and bulbo-urethral glands

(Cowper's), are emitted from the body. It commences at the internal urethral orifice of the urinary bladder and ends on the glans penis. Its average length is 200 mm. (eight inches). It is customary to divide the canal into three parts, from the different characters of the structures which it

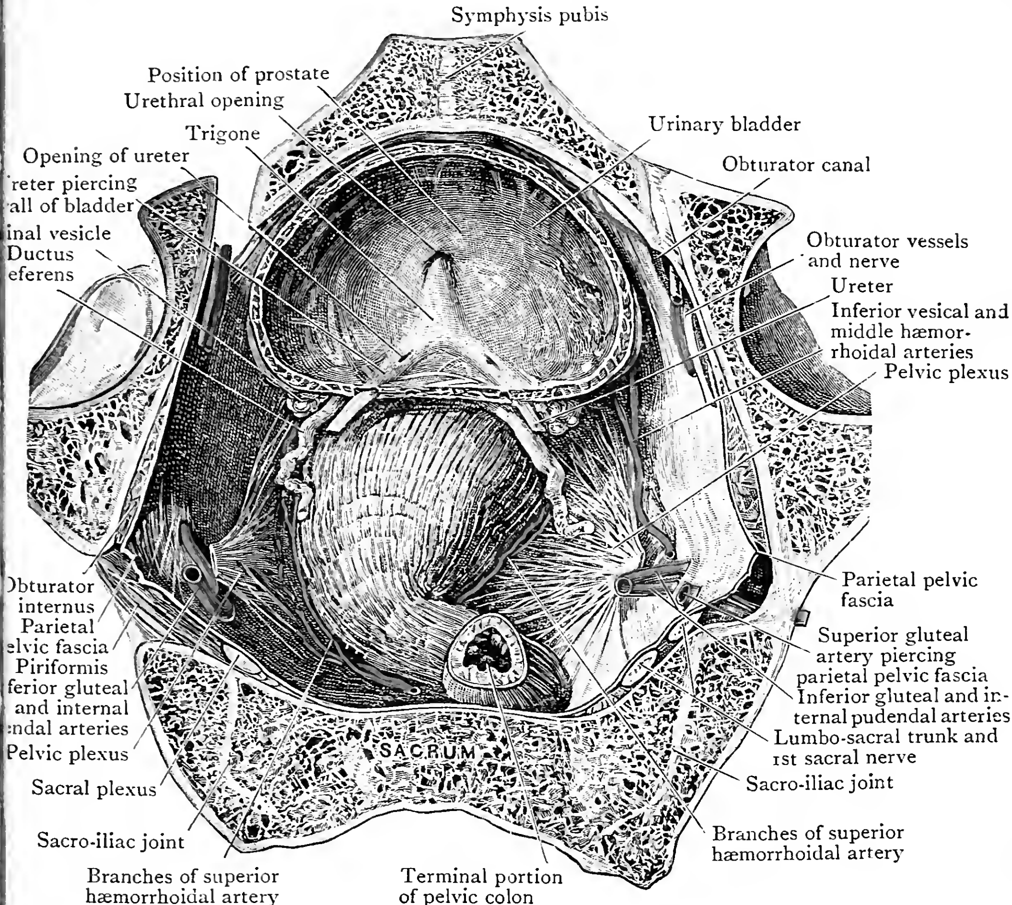

FIG. 201.—Oblique section from above downwards and forwards through the Pelvis. The peritoneum has been removed so as to expose the viscera and the parietal pelvic fascia clothing the pelvic wall.

traverses. The first part, *pars prostatica urethræ*, is contained within the substance of the prostate gland; the second part, *pars membranacea urethræ*, extends from the prostate to the bulb of the corpus cavernosum urethræ, and is surrounded, between the fasciæ of the urogenital diaphragm, by the fibres of the sphincter muscle of the membranous urethra; the third

part, *pars cavernosa urethræ*, traverses the entire length of the corpus cavernosum urethræ.

Pars Prostatica Urethræ.—The prostatic part of the urethra is about 30 mm. (one inch and a quarter) in length. It is fusiform, being wider in the middle than at either its commencement or its termination. It traverses the prostate in front of its so-called middle lobe, and takes a very nearly vertical course through the substance of the prostate. It is the widest, and at the same time the most dilatable, part of the canal.

In connection with the posterior wall or floor of the prostatic portion of the urethra there are certain important features to be noted. The mucous membrane along the median plane is raised into a prominent ridge called the *crista urethræ*. The urethral crest commences a short distance below the internal orifice of the urethra, and extends downwards for about three-quarters of an inch. At first it increases gradually in height, until it forms a prominent eminence, the *colliculus seminalis* or seminal hillock; then its height suddenly diminishes, and, finally, the ridge fades away into the membranous part of the canal (Fig. 200). On each side of the urethral crest the floor of the urethra is a longitudinal depression, termed the *prostatic sinus*, into which the numerous prostatic ducts open. The dissector may render the prostatic ducts evident by squeezing the prostate, when fluid will be found to exude into the sinuses through the ducts. A close inspection of the floor of the urethra, above the crista, will reveal the apertures of the ducts of the so-called middle lobe of the prostate.

Immediately below the seminal hillock the mucous membrane dips backwards and upwards, forming a small *cul-de-sac*, the *utriculus prostaticus*, behind the middle lobe of the prostate (Fig. 203). The orifice of the prostatic utricle is narrow, but the recess widens out towards its blind upper end, and its length, which may be gauged with a probe, varies from 6 to 12 mm. (a quarter to half an inch). It is of interest both practically and developmentally,—practically, because it is sometimes large enough to entangle the point of a small catheter or bougie; and developmentally, because it represents, in the male, the vagina and uterus of the female.

On the margins of the orifice of the prostatic utricle the dissector will find the slit-like orifices of the *ejaculatory*

ducts (Fig. 200). The ducts themselves run downwards,

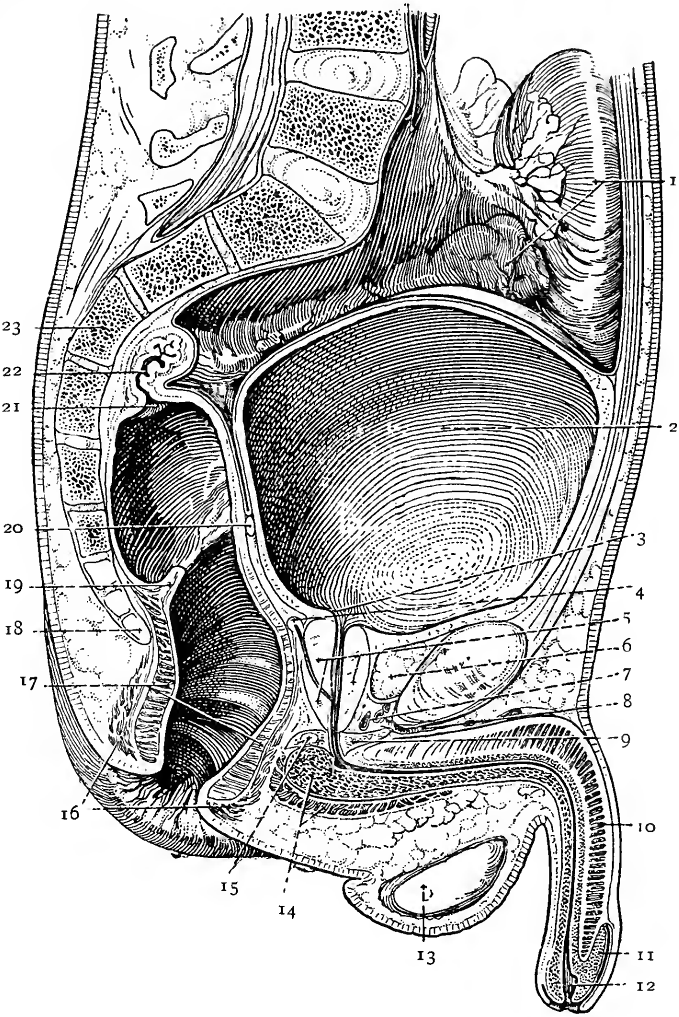

FIG. 202.—Sagittal section of the Pelvis of a young Male Adult with distended Bladder and Rectum.

1. Pelvic colon.
2. Urinary bladder.
3. Uvula of bladder.
4. Seminal vesicle.
5. Prostate.
6. Retro-pubic fat.
7. Pudendal plexus of veins.
8. Dorsal vein of penis.
9. Sphincter urethræ around membranous part of urethra.
10. Corpus cavernosum penis.
11. Glans penis.
12. Fossa navicularis of urethra.
13. Testis.
14. Bulb of urethræ and bulbo-cavernosus muscle.
15. Bulbo-urethral gland.
16. External sphincter.
17. Internal sphincter.
18. 4th piece of coccyx.
19. 2nd transverse rectal fold.
20. Ductus deferens.
21. 1st transverse rectal fold.
22. Commencement of rectum.
23. 3rd sacral vertebra.

along the lateral walls of the utricle, between the middle and

lateral lobes of the prostate. Bristles should be passed through the apertures into the ducts.

Owing to the projection of the urethral crest from the middle of the floor of the canal a transverse section of the prostatic portion of the urethra presents a crescentic figure—the convexity of the crescent being directed forwards and the concavity backwards.

The prostate is very liable to become enlarged as old age approaches. When that happens the most important result is the effect exerted on the urethra. If the enlargement is uniform the canal is merely lengthened, but if excessive growth is localised the enlarged part may compress the urethra and interfere with micturition. When the middle lobe enlarges it projects upwards and forwards, over the internal orifice of the urethra, and forms a kind of ball valve, which may prevent the exit of urine through the internal urethral orifice. It is only in pathological conditions that the so-called middle lobe becomes a very distinct and more or less independent part of the organ. During health it is marked off from the rest of the prostate merely by the utricle and by the passage of the ejaculatory ducts through the substance of the gland.

Pars Membranacea Urethræ.—The membranous part of the urethra is the narrowest and the shortest division of the urethra. It extends from the prostate to the bulb of the urethra, curving gently downwards and forwards, behind the lower border of the symphysis pubis, from which it is distant about 25 mm. (one inch). Its length is barely three-quarters of an inch; and the concavity of its curve is directed forwards and upwards. Throughout its entire length it is enveloped by the fibres of the sphincter urethræ membranaceæ (O.T. compressor urethræ) muscle. Towards its termination the bulbo-urethral glands are placed behind it—one on each side.

The membranous part of the urethra has important relations to the urogenital diaphragm and to the pelvic fascia. As it emerges from the prostate, it pierces the parietal pelvic fascia (*i.e.* the upper fascia of the urogenital diaphragm), and the margins of the aperture through which it passes are carried backwards to become continuous with the sheath of the prostate. At its termination it pierces the inferior fascia of the urogenital diaphragm, about an inch below the

symphysis. It lies therefore in the interval between these two fasciæ (Figs. 194, 199, 200).

The mucous membrane of the membranous part of the urethra is directly surrounded by a thin coat of erectile tissue, and that is embraced by a muscular tunic composed of involuntary fibres arranged circularly.

Pars Cavernosa Urethræ (O.T. **Spongy Portion of Urethra**).—The cavernous portion is the longest division of the urethra.

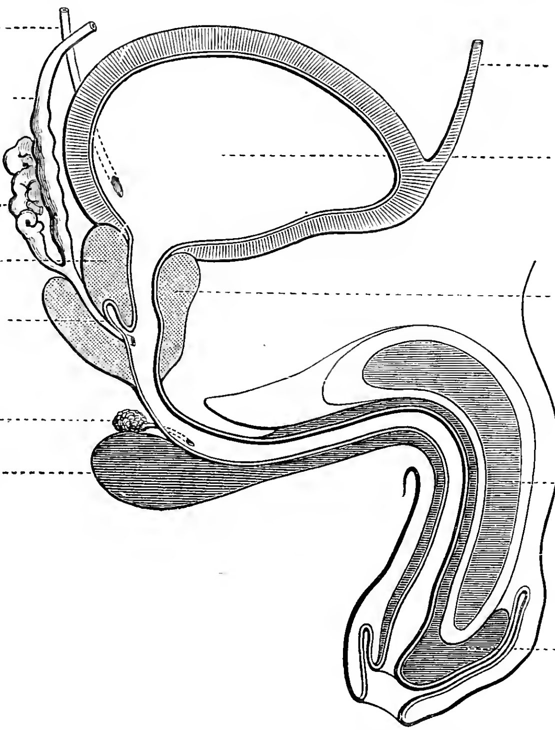

FIG. 203.—Diagram of the Bladder, Urethra, and Penis. (Délépine.)

It is embedded in the substance of the corpus cavernosum urethræ, and its calibre varies considerably at different points. In each expansion of the corpus cavernosum urethræ, viz., the bulb posteriorly and the glans anteriorly, there is a corresponding dilatation of the urethra (Fig. 202); between the dilatations the canal is of uniform diameter, and slightly wider than the membranous portion. The dilatation of the urethra in the glans is termed the *fossa navicularis*. At its orifice, the *external urethral orifice*, the canal is much contracted, and is even narrower than any part of the membranous portion.

The orifice is a vertical slit, and its lower end is connected with the prepuce by a fold of skin, termed the *frenulum præputii.*

In the bulb and in the glans penis the erectile tissue of the corpus cavernosum urethræ is disposed very unequally around the urethra. In the bulb it is massed chiefly below or behind the tube, whilst in the glans it is placed chiefly in front and on each side, a very thin layer lying posteriorly.

The ducts of the bulbo-urethral glands (O.T. Cowper's) pierce the floor and open into the cavernous part of the urethra about 25 mm. (one inch) in front of the inferior fascia of the urogenital diaphragm (Figs. 202, 203). The orifices are minute and difficult to find, but by making a small hole in the wall of the duct, as it emerges from the gland, and passing a fine bristle along it, the dissector may be able to find the opening in the urethral floor. After piercing the inferior fascia of the urogenital diaphragm the ducts proceed forwards, first in the erectile tissue, and then in the submucous layer, towards their terminations.

The walls of the urethra are always in apposition except when urine is flowing through it, and a transverse section through the spongy portion, except at its anterior part, has the appearance of a transverse slit. In the fossa navicularis, however, the slit becomes vertical, showing that there the side walls are in contact.

Mucous Membrane of the Urethra.—The mucous lining of the urethra is continuous posteriorly with that of the bladder, and anteriorly with the integument of the glans penis. It is continuous also with the mucous membrane of the various ducts which open into the urethra. Scattered over its whole surface are the mouths of numerous minute recesses, called *lacunæ urethrales.* As a general rule, their openings are directed forwards, and they are largest on the dorsal wall, where some are large enough to catch the point of a small catheter or bougie, especially the lacuna magna, which is situated in the posterior part of the glans penis.

Direction of the Urethral Canal.—The prostatic portion is directed downwards and very slightly forwards. The membranous part describes a gentle curve behind the symphysis. The concavity of the curve looks forwards and upwards. The cavernous part first ascends, and then curves downwards. The urethra, therefore, in the flaccid condition

of the penis, takes a course in which there are two curves, like the letter S placed on its side. When the penis is raised towards the front of the abdomen the curve in the cavernous part of the canal is obliterated, and there is then only one curve, the concavity of which is directed upwards.

Dissection.—Divide the peritoneum along the junction of the superior surface with the fundus of the bladder, and extend the incision to the side wall of the pelvis, to separate each lateral false ligament from the peritoneum posterior to it. Next, divide the peritoneum in the median plane on the superior surface of the bladder and then divide the superior and posterior walls of the viscus in the median plane. After the division is completed dissect the fundus of the bladder from the deferent ducts and the seminal vesicles, taking care not to injure the ureters as they enter the bladder wall. When the separation is completed note the relations of the bladder and ureters to the more posterior structures.

In the median plane there may be a slight interval between the deferent ducts in which the rectum is separated from the bladder wall merely by the recto-vesical fascia ; that interval, if it is present, corresponds to the middle and upper part of the trigone of the bladder. On each side of it the deferent duct and the seminal vesicle separate the bladder from the anterior surface of the rectum, and, still more laterally, the apical part of the seminal vesicle lies on the levator ani at the side of the rectum, while the lower part of the ureter intervenes between the vesicle and the bladder wall.

Dissection.—The anterior part of the prostate was divided when the urethra was opened. The dissector should now divide the posterior part in the median plane. The rectum must then be divided in the median plane, and afterwards the sacrum and coccyx must be divided vertically by a saw-cut, to the left of the middle sacral artery. The separation of the two halves of the pelvis from each other must be completed by the division of any remaining soft parts with the knife. All the subsequent stages of dissection and the examination of the relations of the viscera can be quite conveniently carried out on each side separately.

Relations of Blood Vessels and Nerves to the Pelvic Fascia.—The dissector should again note that the blood vessels of the pelvis are placed on the peritoneal surface of the pelvic fascia. It follows, therefore, that all the branches pierce the fascia as they pass to the viscera enclosed in the fascia or as they pass out of the pelvis, and they carry with them prolongations of the fascia which blend with their sheaths. There is one exception to the rule, viz., the obturator artery,

which passes over the upper border of the parietal pelvic fascia into the obturator canal. The nerves lie outside the fascia, and, *with the exception of the obturator nerve*, those which are leaving the pelvis do not require to pierce the fascia, but the branches which are to supply the viscera pass through its substance to gain their terminations, and the obturator nerve pierces it posteriorly to gain the interior of the pelvis. The difference between the nerves and blood vessels can be well studied by an examination of the fascia as it passes over the greater sciatic foramen.

The relation of the pelvic blood-vessels to the lining fascia is a matter of some practical importance. The margins of the apertures in the fascia through which the vessels pass are usually strengthened by some encircling fibres; still, a portion of gut may make its way through one or other of the openings in the fascia and form a hernia. Sciatic hernia consists of a protrusion of the gut through the greater sciatic foramen. The hernia may be situated either above or below the piriformis. In the former case it escapes through the aperture in the fascia made by the superior gluteal artery, and in the latter, either through the aperture for the inferior gluteal artery or through that for the internal pudendal artery.

A hernia may occur through the obturator foramen also (obturator hernia). In that case the gut follows the obturator artery over the upper border of the fascia and through the obturator canal.

Intestinum Rectum.—The rectum is the portion of the large intestine which extends from the termination of the pelvic colon, opposite the middle of the third piece of the sacrum, to the point about 38 mm. (one and a half inches) in front of the tip of the coccyx, that is, to the apex of the prostate in the male, and to the apex of the perineal body in the female. At that point it bends abruptly backwards, pierces the rectal layer of pelvic fascia, and becomes the anal canal.

The rectum is about five inches long. For the greater part of its length it is adapted to the anterior surfaces of the sacrum and coccyx (Fig. 202). It is curved, therefore, with the concavity forwards. Beyond the coccyx, the lower 38 mm. (one inch and a half) of the rectum is supported by pelvic floor, formed by the levatores ani muscles, and by the *ano-coccygeal body*. The ano-coccygeal body consists of a dense mass of

fibrous tissue which fills the interval between the coccyx and the anus. It receives the insertion of some of the fibres of the levatores ani muscles. Below the pelvic floor, in the

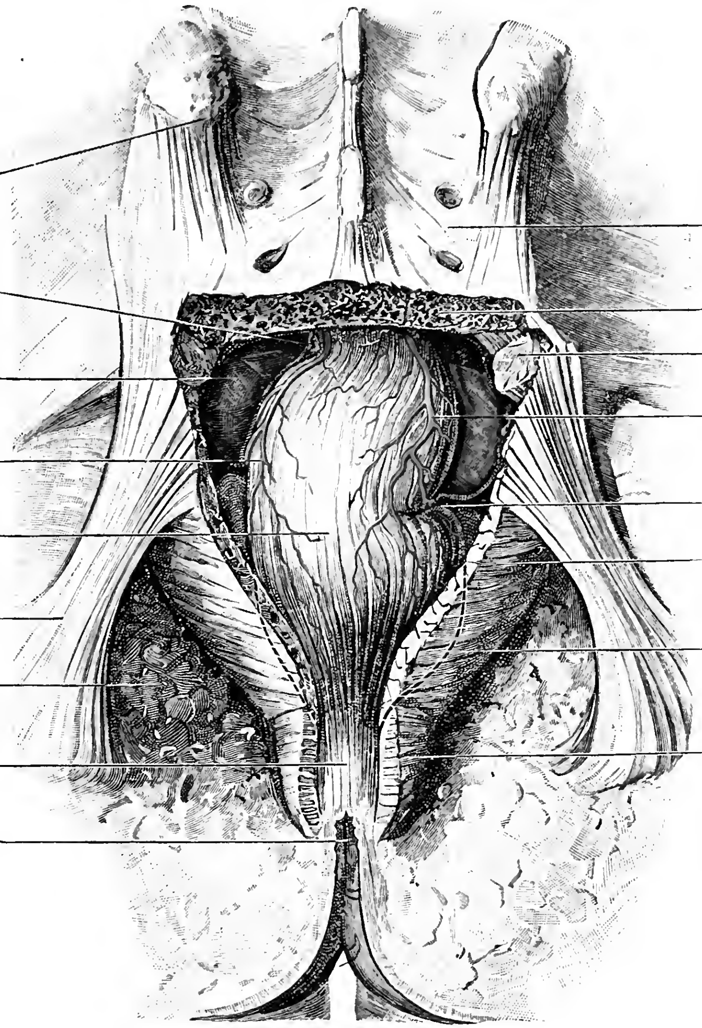

FIG. 204.—Dissection of the Rectum from behind. The sacrum below the 4th sacral vertebra and also the coccyx have been removed. Portions of the levatores ani, coccygei, and external sphincter have also been taken away. (Birmingham.)

region of the ano-coccygeal body, lies the posterior part of the sphincter ani externus muscle.

Peritoneal Relations of the Rectum.—These relations are of practical importance. In its upper third the gut is clothed

with the peritoneum both in front and on the sides; then the peritoneum passes away from the sides, so that in its middle third the gut is covered merely in front; finally, about an inch above the base of the prostate, at the bottom of the recto-vesical excavation, the membrane quits the rectum altogether, and is reflected on to the deferent ducts and the

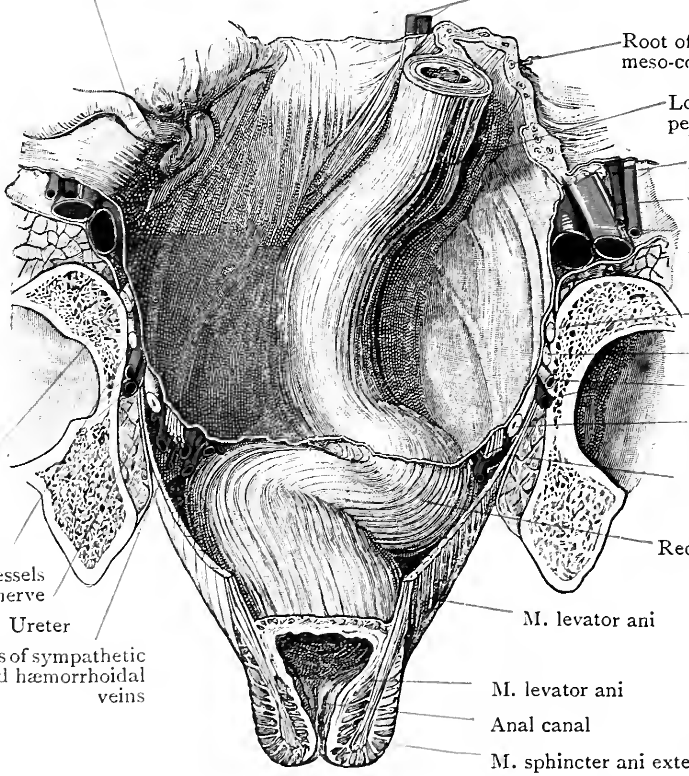

FIG. 205.—Dissection of the Rectum from the front in a specimen hardened by formalin injection. The anterior wall of the pelvis has been removed, and the bladder, prostate, and seminal vesicles have been taken away.

seminal vesicles, as they lie at the fundus of the bladder. The lower third of the rectum is thus altogether devoid of peritoneum. It is separated from the fundus of the bladder and the posterior surface of the prostate by the recto-vesical layer of pelvic fascia; and embedded in the fascia, behind the bladder, are the lower parts of the deferent ducts and the seminal vesicles.

On each side of the upper part of the undistended rectum

is a pararectal fossa, and each lateral part of the wall of the lower portion of the gut is supported by the corresponding levator ani muscle (Figs. 196, 204, 205).

Flexures of the Rectum.—The rectum does not take a straight course along the dorsal wall and floor of the pelvis.

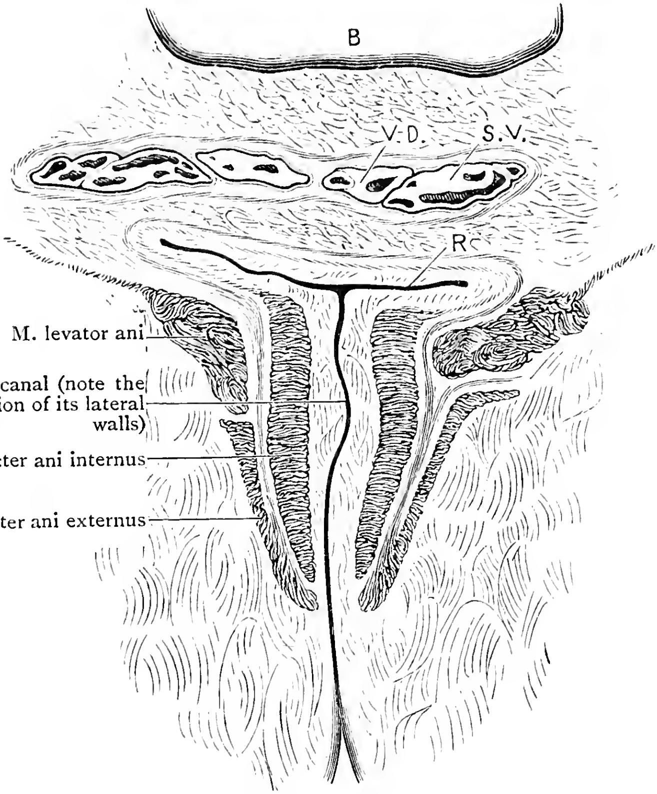

FIG. 206.—Frontal section through the whole length of the Anal Canal. (Symington.)

B. Bladder.
V.D. Ductus deferens.
S.V. Seminal vesicle.
R. Terminal portion of the rectum (note the apposition of its anterior and posterior walls).

On the contrary, it presents three abrupt lateral bends or flexures, of which, as a rule, two are convex to the right and one to the left. The sharply marked infoldings of the wall of the gut opposite the flexures are the cause of the so-called *plicæ transversales recti* (O.T. rectal valves) in the interior of the gut. The flexures are best marked when the gut is distended, but even when it is empty they are usually quite obvious.

The rectum lies between the bladder and prostate in front

and the sacrum and coccyx behind, and, when empty, it has its anterior wall pressed against its posterior wall, and in that condition its lumen appears, in transverse section, as a transverse slit (Fig. 206). Behind the apex of the prostate, where the gut bends to become the anal canal, its anterior wall, in the distended condition, sometimes shows a slight bulging *cul-de-sac*, called the *ampulla recti*, which descends to a lower level than the prostate.

Pars Analis Recti.—The anal canal is the narrow slit-like passage, about 38 mm. (one inch and a half) in length, which leads from the rectum to the anal orifice. The canal com-

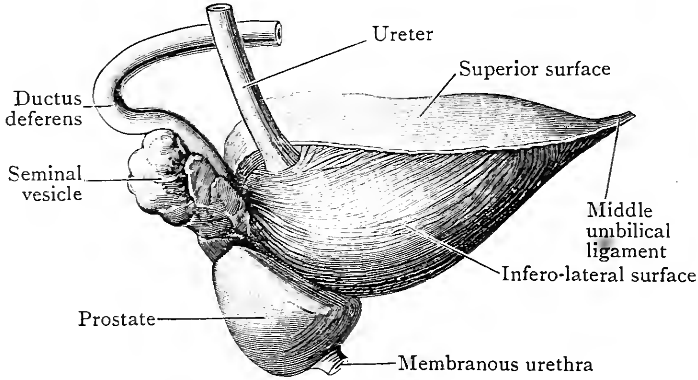

FIG. 207.—Bladder, hardened *in situ*, viewed from the right side. It contained a very small quantity of fluid. (A. F. Dixon.)

mences opposite the apex of the prostate, and proceeds downwards and backwards. It is totally destitute of peritoneum, but it is clothed and supported by a prolongation of the rectal layer of the pelvic fascia, which it pierces. In addition, it is closely surrounded by strong muscles, which keep close guard over it and allow its side-walls to separate from each other only during defæcation. The muscles are:—the *internal sphincter*, developed from the circular muscle of the gut and encircling the canal in nearly its whole length; the *external sphincter*, which surrounds the lower orifice and lower part of the wall; the *levatores ani*, whose medial margins grasp the sides of the canal near its upper end, and pinch in its walls. The membranous part of the urethra and the bulb of the urethra are in front of the canal, but, on account of the backward inclination of the gut, they are separated from it by a mass of fibro-elastic tissue corresponding to the

perineal body of the female. Behind the anal canal is the ano-coccygeal body (Symington).

Vesica Urinaria.—The urinary bladder is a hollow viscus, with strong muscular walls, which acts as a temporary reservoir for the urine before it is emitted from the body by the process of micturition. Its form, and, in a great measure, its position and relations, are influenced by the amount of fluid it contains, and by the age of the subject.

The different forms which the bladder assumes, under constantly changing conditions, render its description a matter of serious difficulty. As a rule it is found in the dissecting room with contracted walls and empty. For that reason, and also because our information regarding the empty bladder is more exact, the dissector should study, in the first place, the form it presents when in that condition, and afterwards consider the changes it undergoes as it becomes filled with urine. The following description is based upon the account given by Professor Dixon.

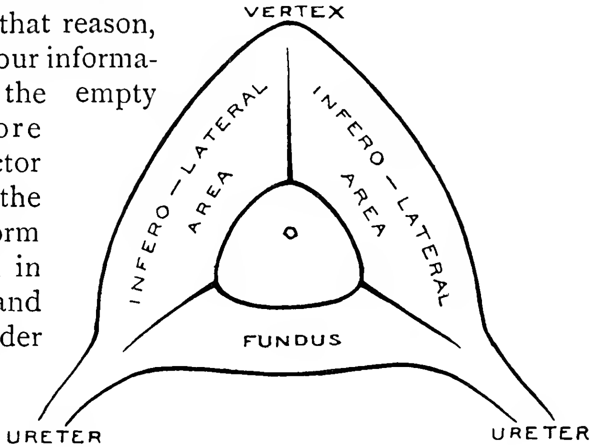

FIG. 208.—Diagram of the Empty Bladder, seen from below. (After A. F. Dixon.)

The *empty bladder* lies completely within the cavity of the pelvis, in the adult. It has the form of a three-sided pyramid, possessing an apex, a base or fundus, and three surfaces, viz.,—a superior surface and two infero-lateral surfaces.

The *fundus* looks backwards towards the rectum, from which it is separated by—(1) the recto-vesical fascia, (2) the deferent ducts and seminal vesicles, which are enclosed in the fascia, and (3) the peritoneum of the anterior wall of the recto-vesical excavation.

The *apex* is placed in relation with the upper part of the symphysis pubis. It is continuous with a strong fibrous cord, the ligamentum umbilicale medium (*urachus*), which proceeds upwards, on the posterior aspect of the anterior

abdominal wall, to the umbilicus. The urachus is the remains of the cephalic part of the ventral section of the cloaca of the embryo.

The *superior surface* looks upwards and backwards, and is completely covered with peritoneum. It supports some coils of small intestine and, not uncommonly, a coil of the pelvic colon. It is slightly convex; it is triangular in outline, and is bounded by three borders, viz.—two lateral, which diverge from the apex, and a posterior, which separates it from the base. The lateral and posterior borders meet at the posterior angles, and at those angles the ureters enter the bladder wall.

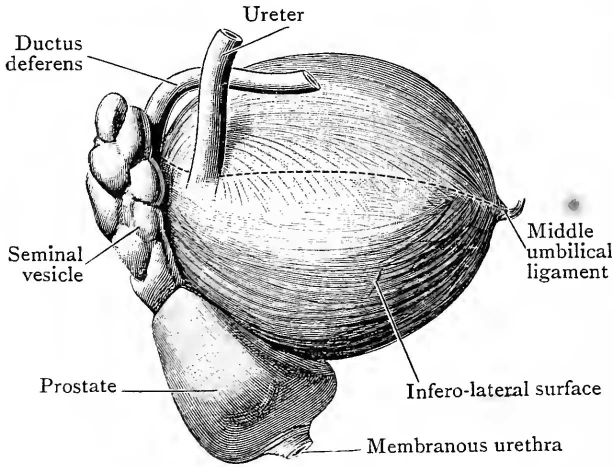

FIG. 209.—Bladder, hardened *in situ*, viewed from the right side. It contained a slightly larger amount of fluid than the specimen depicted in Fig. 207. (A. F. Dixon.)

Each lateral border is in relation with the side-wall of the pelvis, along a line considerably below the level of the deferent ducts and the umbilical artery.

The *infero-lateral surfaces* are separated from each other by a rounded, anterior border. Each infero-lateral surface forms part of the posterior wall of the cave of Retzius, and is separated by extra-peritoneal fat from the back of the body of the pubic bone and the fascia covering the pelvic surfaces of the corresponding obturator internus and the levator ani muscles.

The anterior border, which separates the infero-lateral surfaces, lies behind the symphysis and above and in front of the prostate. It extends downwards and backwards to the internal

urethral orifice, which separates it from the lower end of the fundus. It is separated from the back of the symphysis and the pubo-prostatic ligaments by the retro-pubic pad of fat. The retro-pubic pad appears in median sections of the pelvis as a small wedge-shaped mass of soft, fatty areolar tissue (Fig. 210); it is part of the extra-peritoneal fat, and it adapts itself to the changing conditions of the bladder.

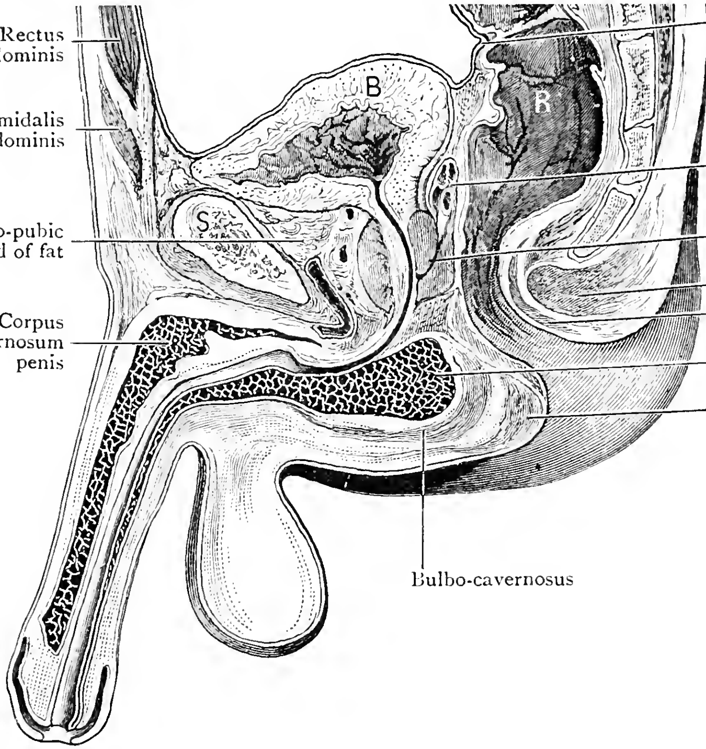

FIG. 210.—Median section through the Pelvis of an Adult Male. The bladder is nearly empty, and the urethra is divided along its whole length.

R. Rectum. S. Symphysis. B. Bladder.

The internal urethral orifice, by which the urine leaves the bladder, is placed at the most dependent part of the bladder, which is situated at the junction of the fundus with the anterior border, in the region termed the *neck of the bladder*. It is surrounded by the base of the prostate, which presents a structural continuity with the bladder wall.

Changes in the form of the Urinary Bladder as it becomes

filled with Urine.—The neck of the bladder is firmly fixed in position by its attachment to the prostate and by its connection with the upper fascia of the pelvic diaphragm, and the prostate is securely held in place by its strong sheath of pelvic fascia; therefore, as the bladder becomes filled, the internal urethral orifice suffers very little change of position. It is only in cases of excessive distension that any marked change in its level becomes manifest, and under such circumstances the internal urethral orifice sinks, to a certain extent, in the pelvic cavity.

As the bladder fills, its superior wall is raised from the fundus and infero-lateral walls. All its surfaces are increased in area, and the borders, which in the empty bladder intervene between them, become rounded off and finally obliterated. The organ thus becomes oval in form, and the walls, which are thick and firm in the contracted state, become comparatively thin. The apex appears above the symphysis pubis, and, as distension goes on, the organ rises higher and higher into the hypogastric region until a considerable extent of its wall becomes applied to the abdominal wall above the pubis. The infero-lateral surfaces of the distending bladder encroach on the paravesical fossæ, and finally obliterate them, thus coming into contact with a greater extent of the side walls of the pelvis.

When the bladder is excessively distended it assumes a spherical form or, in some cases, an ovoid form, with the large end above (Figs. 202, 211). In the latter case its long axis is no longer horizontal, but oblique, being directed from above downwards and backwards.

When the urine is ejected from the bladder, the superior wall descends till it becomes approximated to the infero-lateral walls and the fundus. The viscus, therefore, becomes flattened from above downwards, and comes to lie again entirely within the cavity of the pelvis minor. When such a bladder is examined in a median section, in a subject from whom the urine was expelled shortly before death, the walls of the bladder are thick and firm, and the lumen of the viscus may be reduced to a mere slit. The part of the lumen which lies behind the internal urethral orifice is called the posterior limb, and the part in front of the orifice, bounded by the approximated superior and infero-lateral walls, is called the anterior limb of the cavity. The anterior

limb is long and nearly horizontal. The posterior limb is short and sometimes barely recognisable; further, it is oblique or vertical, and joins the anterior limb at an angle. Viewed in median section, therefore, the lumen of the perfectly empty bladder usually forms two limbs of a Y, the stem being the urethra.

In other cases the empty bladder is firm and rounded,

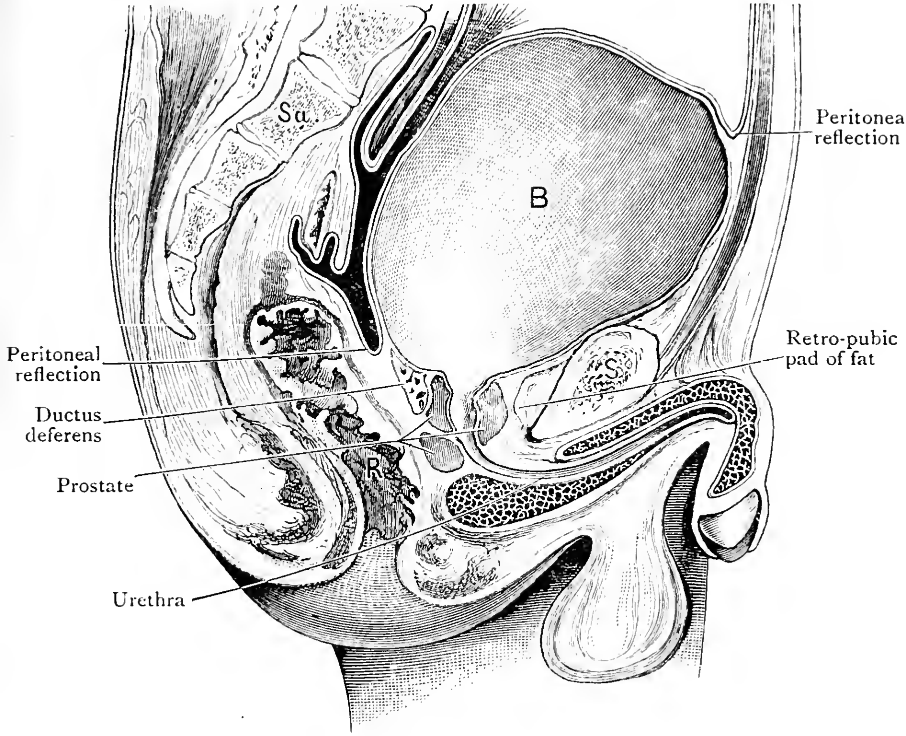

FIG. 211.—Median section through a Male Pelvis in which the Bladder was greatly distended.

B. Bladder. S. Symphysis pubis.
R. Rectum. Sa. Sacrum.

and when divided in the median plane its cavity appears as a single slit, which is directly continuous with the urethra.

Relation of the Peritoneum to the Urinary Bladder.—In the empty bladder only the superior surface is directly covered with peritoneum. The membrane is separated from the upper part of the fundus by the seminal vesicles and the deferent ducts. The infero-lateral surfaces are entirely devoid of peritoneum.

When the bladder fills it rises into the hypogastric region, and it is important to note that the peritoneal reflection from the apex is raised along with the organ, and, as a result, a considerable area of the bladder wall, below the ligamentum umbilicale medium (*urachus*), becomes applied directly to the anterior abdominal wall, no peritoneum intervening. Consequently, in those cases of retention of urine in which a catheter cannot be passed into the bladder through the urethra, relief can be given, without fear of injuring the peritoneum, by puncturing the bladder, with a trocar and cannula, immediately above the symphysis pubis in the median plane (Figs. 202, 211).

Laterally, also, the line of peritoneal reflection is raised until it may appear to leave the lateral border of the bladder along the line of the ductus deferens, as the duct passes backwards along the side wall of the pelvis, or even as high as the level of the umbilical artery.

Posteriorly, the sacro-genital folds are opened out and obliterated to provide a covering for the expanding basal portion of the bladder, but the level of the reflection of the peritoneum which forms the bottom of the recto-vesical excavation undergoes no change. When the rectum is distended the recto-vesical reflection assumes a higher level, but that is not due to any change in the position of the peritoneum in relation to the bladder, but to the entire bladder, with the reflection, being pushed upwards and forwards by the expanding gut.

The Urinary Bladder in New-Born Children.—In the new-born infant the bladder differs both in form and in position from the bladder of the adult. It is more or less piriform, the narrow end passing into the urethra, and there is little or no appearance of a basal portion (Fig. 212). Further, it is placed very much higher. The internal urethral orifice is at the level of the upper border of the symphysis pubis, and the antero-lateral surfaces of the organ, devoid of peritoneum, lie in direct contact with the abdominal wall (Symington). As growth goes on the urethral orifice sinks rapidly from the period of birth up to the fourth year, and more slowly from that period up to the beginning of the ninth year. Then it remains stationary till puberty, after which it sinks slowly till it attains its normal adult position (Disse). It should be noted also that the recto-vesical re-

flection of peritoneum, in the infant at birth, is at the level of the base of the prostate, which, at that period, is relatively little developed.

Ureters in the Pelvis Minor.—Having crossed the lower end of the common iliac artery, or the upper end of the external iliac artery, at the brim of the pelvis minor, each ureter descends, along the front of the hypogastric artery and its anterior division, till the level of the visceral layer of the pelvic fascia is reached, *i.e.*, the level of the spine of the ischium. It then turns medially and forwards on the upper surface of the visceral fascia. In that part of its course it passes below to the deferent duct (Fig. 192), pierces the vesical layer of the visceral fascia, and enters the bladder

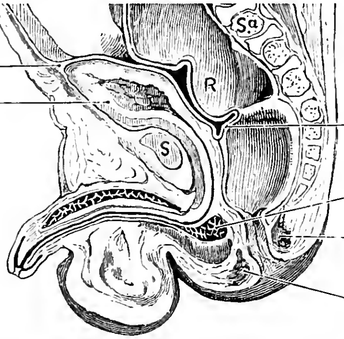

FIG. 212.—Median section through Pelvis of a newly-born full-time Male Infant.

R. Rectum. Sa. Sacrum. S. Symphysis pubis.

wall at the corresponding posterior angle, immediately in front of the upper end of the seminal vesicle. Its point of entry into the bladder wall is about 37 mm. (one and a half inches) above the base of the prostate, and about 50 mm. (two inches) from its fellow of the opposite side. It is covered on its anterior and medial surfaces by the peritoneum, which it raises into a ridge, and the peritoneal-covered surfaces are in relation, on the right side, with coils of small intestine, and, on the left side, with the pelvic colon. To its lateral side, from above downwards, lie the umbilical artery, the obturator nerve, the obturator artery, the inferior vesical artery, and, occasionally, the middle hæmorrhoidal artery, but that vessel may pass behind the ureter.

The obturator vein, which lies at a lower level than the artery, may pass either lateral to or medial to the ureter, on its

way to the hypogastric vein. As a rule there is no vein with the superior vesical artery. The veins which correspond to the inferior vesical and middle hæmorrhoidal arteries are irregular in number and large in size; they emerge from venous plexuses on the walls of the respective viscera, and enclose the lower part of the ureter in tortuous coils as they pass to the hypogastric vein.

Prostata.—The prostate is a solid body, partly glandular and partly muscular, which embraces the neck of the bladder and surrounds the first part of the urethra.

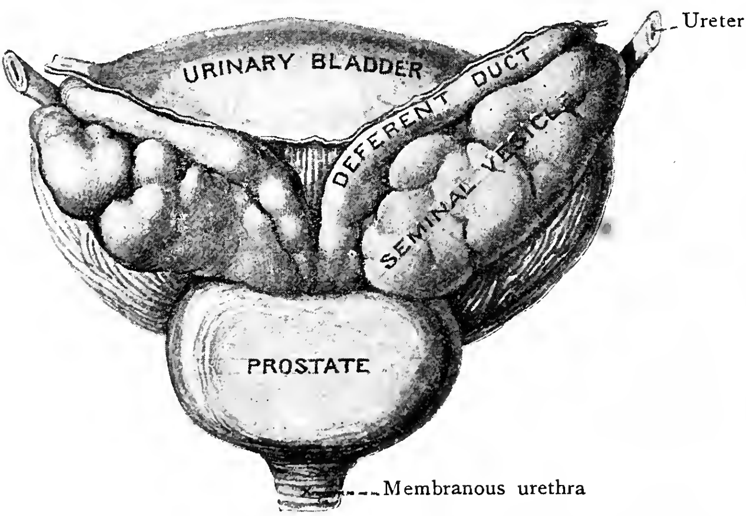

FIG. 213.—Basal aspect of Bladder, Seminal Vesicles, and Prostate, hardened by formalin injection.

It is conical in shape, with its base directed upwards and its apex downwards. In size it is variable, but its average dimensions are: *length*, about 31 mm. (one and a quarter inches) from base to apex; *breadth*, 38 mm. (one and a half inches) from side to side at its broadest part.

Position.—The prostate rests upon the anterior aspect of the lowest part of the rectum. Its apex is about 38 mm. (one inch and a half) distant from the anus, whilst its anterior border lies 18 mm. (three-quarters of an inch) behind the lower part of the symphysis pubis. As already mentioned, the prostate is enclosed in a strong fibrous *sheath*, derived from the pelvic fascia. The fascial sheath is firmly fixed not only by the pubo-prostatic ligaments, which form a part

of it, but also, at the apex of the gland, by the continuity which is established between the sheath and the upper fascia of the urogenital diaphragm. The connections of the sheath prevent the prostate altering its position in response to the continual changes which occur in the state of the distension of the bladder. It is a matter of importance to notice that the prostate lies loosely in its sheath. Only in the median

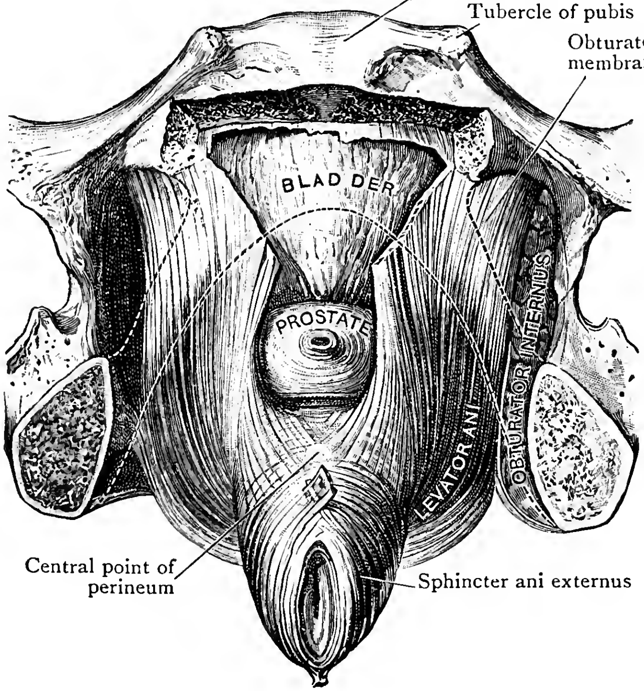

FIG. 214.—Dissection of the two Levatores Ani. The lower part of the pelvis is tilted forwards and the pubic arch has been removed. Both fasciæ of the urogenital diaphragm, the parts in relation to them, and the pubic origins of the levatores ani, have also been taken away. The portion of bone removed is indicated by the dotted lines.

plane, in front, and around the urethra as it emerges from the gland, is there any degree of adhesion between the prostate and its fascial envelope.

Within the sheath, and attached more closely to its inner surface than to the prostate, is a plexus of thin-walled veins, called the *pudendal plexus* (Fig. 199). The plexus is spread over the anterior border and the lateral surfaces of the prostate, and is denser in the latter situations than in the former. It receives the dorsal vein of the penis; it com-

municates with the internal pudendal vein, and it becomes continuous above, at the base of the prostate, with the prostatico-vesical venous plexus, from which the blood is drained by the inferior vesical veins.

Immediately surrounding the prostate, and quite independent of the sheath, is the fibrous *capsule* of the prostate. The fibrous capsule varies in thickness, in some cases being extremely thin and in others forming a distinct cortex. In association with operations for the removal of the prostate, now frequently performed, it is important to notice that the capsule has but very slight connection either with the venous plexus or with the sheath of pelvic fascia. It is on that account that the gland can be so easily shelled out from its surroundings.

The prostate presents for examination a *base* or superior surface, an *apex* or inferior extremity, a *posterior surface*, two *lateral surfaces*, and an *anterior*, *rounded border*. The *base* looks upwards. It surrounds the internal urethral orifice, and, in a considerable part of its extent, is structurally continuous with the bladder. Around the greater part of its circumference, however, it is separated from the bladder by a groove in which is lodged a group of thin-walled veins, known as the *prostatico-vesical plexus*. The *apex* abuts against the upper fascia of the urogenital diaphragm (Fig. 200). The posterior surface is usually a flat triangular area which rests on the anterior aspect of the rectum, but, occasionally, it is marked by a median, vertical groove. The two lateral surfaces rest upon the levatores ani muscles, and are separated from each other by the prominent, rounded, anterior border, from which the urethra emerges immediately above the apex of the gland.

The delicate ejaculatory ducts pierce the base of the prostate a short distance behind the internal urethral orifice of the bladder, and, as they descend, through the substance of the prostate, they separate the so-called middle lobe from the remainder of the gland, which is generally spoken of as consisting of two lateral lobes, though there is no structural demarcation between them.

The blood-supply of the prostate is derived from the inferior vesical and middle hæmorrhoidal arteries.

Vesiculæ Seminales.—The two seminal vesicles lie between the fundus of the bladder and the rectum. Each is about 50 mm. (two inches) in length and is piriform in shape.

The lower, pointed end of each vesicle rests on the base of the prostate, and the blunt, upper end lies in the sacro-genital fold of peritoneum, in relation with the recto-vesical excavation of peritoneum, and with the entrance of the ureter into the bladder. At their lower extremities the vesicles are separated from each other only by the interposed deferent ducts, but they diverge as they ascend, and their upper ends are wide apart. They are enclosed, together with the deferent ducts, which lie along their medial sides, in a dense sheath derived from the recto-vesical layer of the visceral pelvic fascia.

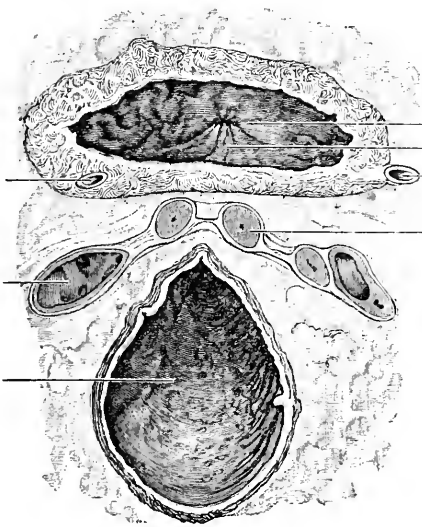

FIG. 215.—Horizontal section through the Bladder and Rectum at the level at which the ureters enter the bladder.

Each vesicula seminalis is in reality a tube, 12.5 to 15 cm. (five or six inches) long. It is bent repeatedly upon itself and is bound into vesicular form by the dense areolar tissue in which it is embedded. When it is unravelled, several blind diverticula will be found to proceed from the main tube. The lower end of the tube, which is called the *excretory duct*, emerges from the pointed lower end of the vesicle and joins with the ductus deferens, at an acute angle, to form the *ejaculatory duct*.

Ductus Deferens (O.T. **Vas Deferens**).—The deferent duct, or duct of the testis, was previously traced to the abdominal inguinal ring (p. 237), through which it enters the abdomen.

At the abdominal inguinal ring it separates from the other constituents of the spermatic cord, hooks, medially, round the inferior epigastric artery, and descends on the medial side of the external iliac vessels into the pelvis minor. It then runs backwards, on the side wall of the pelvis, immediately external to the peritoneum, through which it is clearly visible, and it crosses, in turn, the umbilical artery, the obturator nerve, the superior vesical artery, and the ureter. Immediately beyond the ureter it turns sharply medially towards the fundus of the bladder, enters the pelvic fascia, comes into relation with the blunt, upper end of the seminal vesicle, and runs downwards and medialwards, in close apposition with the upper or medial side of the vesicle, to the base of the bladder. There, lying close to the median plane, and to its fellow of the opposite side, it turns vertically downwards to the base of the prostate. The lower part of the duct is dilated, tortuous, and sacculated, and is termed the *ampulla*, but its lower end narrows greatly and joins with the duct of the seminal vesicle to form the ejaculatory duct.

Ductus Ejaculatorius.—The ejaculatory duct is formed, immediately above the base of the prostate, by the union of the excretory duct of the seminal vesicle with the termination of the ductus deferens. Its walls are thin and delicate; it is therefore easily torn. Its length is about 18.6 mm. (three-quarters of an inch), and it descends, through the substance of the prostate between the middle and lateral lobes, to the corresponding margin of the opening of the prostatic utricle, where it opens into the prostatic part of the urethra.

Triangle on the Base of the Bladder.—It is customary to describe a triangle at the base of the bladder, bounded laterally by the deferent ducts, and above by the reflection of the peritoneum at the bottom of the recto-vesical excavation. When the pelvic viscera are hardened *in situ*, by formalin injection, such a space can hardly be said to exist, owing to the approximation of the ampullæ of the deferent ducts, but it is possible that when the bladder is distended the space between the deferent ducts may be increased.

Dissection.—The peritoneum has already been lifted up and the extraperitoneal fat removed to show the visceral branches of the hypogastric artery. The pelvic fascia must now be removed and the remaining branches of the hypogastric artery and the accompanying veins must be followed, so far as they lie in the pelvis. Accompanying the arteries a number of nerve

twigs from the pelvic plexuses, and from the third and fourth sacral nerves, should be noticed and preserved. As the dissector approaches the posterior pelvic wall he must pull the rectum forwards, and as he does that he should note that branches from the sympathetic trunk and from the third and fourth sacral nerves pass to its walls. Whilst the pelvic fascia is being

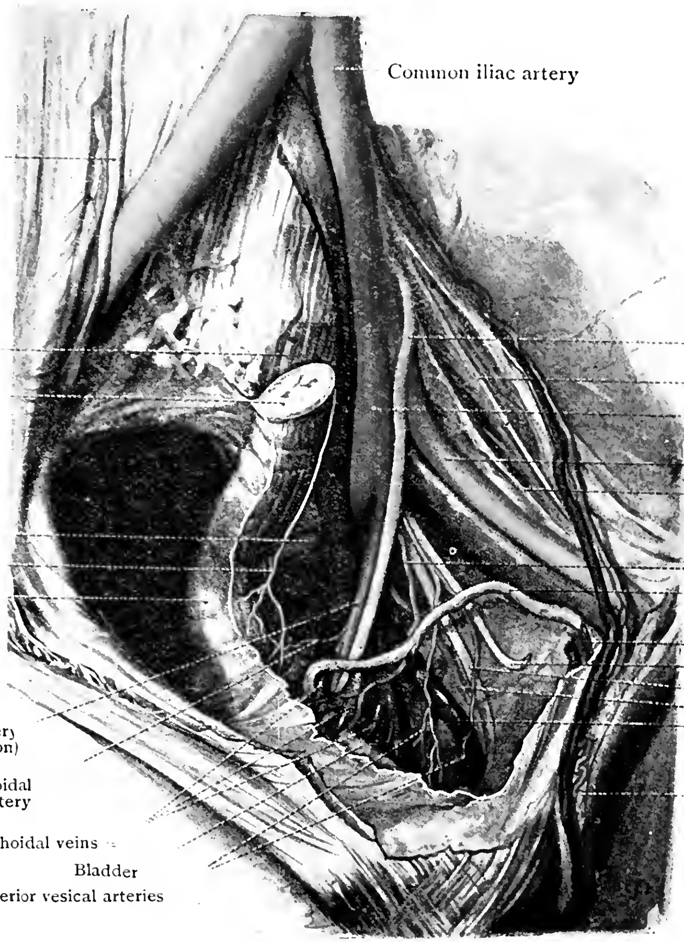

FIG. 216.—The Structures exposed in the left half of the Pelvis Minor by the removal of the peritoneum and extraperitoneal fat.

removed from the sacral region care must be taken not to injure the pudendal and coccygeal plexuses and their roots and the sympathetic trunk, which all lie immediately behind the fascia. The lateral sacral arteries will serve as useful guides, for as they run medially, from the posterior division of the hypogastric artery, they lie in front of the sacral plexus, and as one or other of them descends along the front of the sacrum it lies immediately to the lateral side of the sympathetic trunk and in

front of the roots of the sacral nerves as they issue from the anterior sacral foramina.

Pelvic Blood-Vessels.—The pelvic arteries, in the male, are the following :—

1. The hypogastric and its branches (upon each side).
2. The middle sacral } (near the median plane).
3. The superior hæmorrhoidal } (near the median plane).

Arteria Hypogastrica (O.T. **Internal Iliac Artery**).—Each hypogastric artery is the medial terminal branch of the corresponding common iliac artery; it is a short, wide vessel, about 38 mm. (one and a half inches) long, and it is smaller in the adult than the external iliac artery. It commences opposite the sacro-iliac articulation, at the level of the lumbo-sacral articulation; it runs downwards and backwards in the pelvis, and ends, near the upper border of the greater sciatic notch, by dividing into an anterior and a posterior division.

Relations.—To its *lateral side* are the obturator nerve, and, at a higher level, the external iliac vein, which separates it from the medial border of the psoas major (Figs. 216, 224). In *front* is the ureter, and *behind* is the hypogastric vein (Fig. 216). *Medially*, it is covered by peritoneum, which separates the right artery from coils of the ileum, and the left from the pelvic colon. In the female the ovary and the ovarian end of the uterine tube are anterior relations of the artery and of the ureter, from both of which they are separated by the parietal peritoneum.

Condition in the Fœtus.—The condition of the hypogastric artery in the fœtus is very different. It is twice as large as the external iliac artery. Instead of terminating at the sciatic notch it runs forwards, and ascends, on the posterior aspect of the anterior abdominal wall, to the umbilicus, through which it passes, in company with its fellow of the opposite side and the umbilical vein. Outside the abdominal cavity the hypogastric arteries enter the umbilical cord, and, twining spirally round the umbilical vein, they reach the placenta, where the impure blood which they carry is brought into relation with the maternal blood.

After birth, when the umbilical cord is ligatured and divided, a portion of each hypogastric artery, from the umbilicus to the sciatic notch, undergoes atrophy, and is ultimately converted into a fibrous cord known as the

lateral umbilical ligament. The lateral umbilical ligament springs from the lower end of the trunk, or from the anterior division, of the hypogastric artery, and runs forwards on the side wall of the pelvis to the apex of the bladder, whence it ascends to the umbilicus. At the side of the pelvis it lies at a higher level than the obturator nerve, and it passes to the lateral side of the ductus deferens. For about the first 50 mm. (two inches) of its extent it has a small lumen, and from that part one or more superior vesical branches arise.[1]

Branches of the Divisions of the Hypogastric Artery.

Anterior Division.		Posterior Division.	
Parietal.	Visceral.	Parietal.	Visceral.
Obturator. Internal pudendal. Inferior gluteal.	Superior vesical. Inferior vesical. Middle hæmorrhoidal.	Ilio-lumbar. Lateral sacral. Superior gluteal.	None.

Arteriæ Vesicales Superiores.—As a rule there are two or three slender superior vesical arteries which spring from the umbilical artery. They supply the greater part of the superior and infero-lateral surfaces of the bladder, and occasionally one of them gives off the *artery to the ductus deferens*, an extremely slender branch, which can be traced along the deferent duct to the testis.

Arteria Vesicalis Inferior.—The inferior vesical artery is usually of larger size than any of the superior vesical branches. It crosses in front of the ureter and over or under the angular bend of the deferent duct, to reach the base of the bladder, where it ramifies, sending twigs to the bladder, the seminal vesicle, the ductus deferens, and the prostate. It frequently gives off the *artery to the ductus deferens*.

[1] Although the portion of the hypogastric artery of the fœtus which runs from the greater sciatic notch through the umbilicus to the placenta is the direct continuation of the main trunk, it is frequently called the *umbilical artery* and is spoken of as a branch of the hypogastric artery. When this terminology is adopted the lateral umbilical ligament is said to be the remains of the umbilical artery.

Arteria Hæmorrhoidalis Media.—The middle hæmorrhoidal artery may arise independently or in common with the inferior vesical, and it may pass in front of the lower part of the ureter or behind it. It is distributed mainly to the muscular coat of the rectum, where it anastomoses with the superior and inferior hæmorrhoidal vessels. It supplies twigs also to the prostate, the deferent ducts, the seminal vesicles, and the bladder.

Arteria Obturatoria.—The obturator artery runs forwards on the inner aspect of the pelvic wall to the upper margin of the obturator foramen, where it enters the obturator canal. In the pelvis it lies in the extraperitoneal fat below the obturator nerve and above the vein. It gives some small *iliac branches* to the iliac fossa, and a *pubic branch*, which ascends on the pelvic surface of the pubis to anastomose with the pubic branch of the inferior epigastric artery. The anastomosis, if formed, may become converted into either the commencement of the obturator, which then arises from the inferior epigastric, or the commencement of the inferior epigastric, which then arises from the obturator, and, in either case, it may pass to the medial side or to the lateral side of the femoral ring; thus it attains a close relationship with a femoral hernia. (See p. 260.)

Arteria Pudenda Interna (O.T. Internal Pudic Artery).—In the pelvis minor the internal pudendal artery proceeds downwards in front of the piriformis muscle and the sacral nerves. As it leaves the pelvis minor it passes between the piriformis and the coccygeus muscles, and through the lower part of the greater sciatic foramen.

Arteria Glutæa Inferior (O.T. Sciatic Artery).—The inferior gluteal artery is usually the largest branch given off by the anterior division of the hypogastric artery, and, as a rule, it lies behind the internal pudendal. It passes down in front of the piriformis muscle and the sacral plexus, and frequently through one of the loops of the plexus. It leaves the pelvis by passing between the piriformis and coccygeus muscles, and through the lower part of the greater sciatic foramen (Fig. 216).

Arteria Ilio-lumbalis.—The ilio-lumbar artery springs from the posterior division of the hypogastric artery and passes upwards, laterally, and backwards, behind the obturator nerve, the external iliac vessels, and the psoas major muscle, into the iliac fossa, where it divides into lumbar and iliac

branches. The *lumbar branch* runs upwards, and terminates in the substance of the quadratus lumborum and psoas major muscles, where it anastomoses with the lower lumbar arteries. It gives off a small *spinal branch*, which enters the vertebral canal through the intervertebral foramen between the fifth lumbar vertebra and the sacrum. The *iliac branch* breaks up into branches, some of which run laterally in the substance of the iliacus and others between that muscle and the bone. One of the latter set enters the nutrient foramen in the iliac fossa. The terminal branches reach the crest of the ilium, where they anastomose with the deep circumflex iliac and lumbar arteries.

Arteria Glutæa Superior (O.T. **Gluteal Artery**).—The superior gluteal artery is the largest branch of the hypogastric artery, and may be regarded as the continuation of its posterior division. Its course in the pelvis is short. It passes backwards, between the lumbo-sacral trunk and the first sacral nerve, and leaves the pelvis minor through the upper part of the greater sciatic foramen, above the piriformis muscle.

Arteria Sacralis Lateralis.—The lateral sacral artery is occasionally a single vessel, but more commonly it is represented by two branches, which run medialwards, in front of the sacral nerves, to the lateral borders of the anterior sacral foramina. The upper of the two enters the first sacral foramen. The lower runs downwards, lateral to the foramina and the sympathetic trunk, and in front of the roots of the sacral nerves, to the tip of the coccyx where it anastomoses with the middle sacral artery. As it descends it sends spinal branches into the anterior sacral foramina. The spinal branches assist the upper artery to supply the membranes and nerve-roots within the canal; then they emerge through the posterior sacral foramina and anastomose with branches of the superior gluteal artery.

Arteria Hæmorrhoidalis Superior.—The superior hæmorrhoidal artery is the direct continuation of the inferior mesenteric artery. It enters the root of the pelvic mesocolon and descends in it as far as the third piece of the sacrum. There it divides into two branches which proceed downwards, one on each side of the rectum. Each of the branches soon breaks up into smaller branches, which range themselves round the gut and pierce its muscular coat about the middle of its length. Within the

submucous coat they proceed down to the anal canal, where it is usual to find one within each rectal column (p. 466). The terminal twigs anastomose freely with each other and with branches of the middle and inferior hæmorrhoidal arteries.

Arteria Sacralis Media.—During the dissection of the abdomen the middle sacral artery was seen springing from the back of the termination of the aorta, above the common iliac arteries. It descends in front of the bodies of the lowest two lumbar vertebræ and behind the left common iliac vein. Reaching the sacrum, it continues downwards in the median plane to the tip of the coccyx. It supplies the glomus coccygeum, and, from each side, it gives off small twigs which anastomose with the lateral sacral arteries.

Veins of the Pelvis.—The arrangement of the veins in the pelvis corresponds in great measure to that of the arteries; but there are some important differences, viz. :—

(1) The *deep dorsal vein of the penis*, instead of joining the internal pudendal vein, enters the pelvis and divides into two branches, which join the pudendal plexus of veins.

(2) The *ilio-lumbar* and *middle sacral veins* pour their blood, as a rule, into the common iliac veins.

(3) The veins around the prostate, bladder, and rectum are large and numerous, and form dense plexuses, which communicate freely with each other. The *pudendal* (O.T. *prostatic*) and *prostatico-vesical plexuses* have already been noticed; the blood is drained from them chiefly by the vesical veins. The *hæmorrhoidal plexus* consists of two parts, one in the submucous coat and one on the surface of the gut. It is the latter which is seen in the dissection. The blood is drained from it by three groups of channels, viz., the *superior hæmorrhoidal vein*, which ends in the inferior mesenteric vein; the *middle hæmorrhoidal veins*, which end in the hypogastric veins; and the *inferior hæmorrhoidal veins*, which go to the internal pudendal veins. The hæmorrhoidal plexus is therefore a link between the portal and systemic systems of veins. This is of practical importance in association with the production of hæmorrhoids or piles, which are due to a varicose condition of the hæmorrhoidal veins. The portal vein and its larger tributaries are without valves; consequently, anything which retards the flow of blood through the portal system will react upon the hæmorrhoidal plexus,

cause its distension, and predispose to the formation of hæmorrhoids.

Vena Hypogastrica (O.T. **Internal Iliac Vein**).—Each hypogastric vein is a large venous trunk which lies behind the corresponding hypogastric artery. Its tributaries correspond to the branches of the hypogastric artery, except that the ilio-lumbar vein opens into the common iliac vein.

The Lymph Vessels of the Pelvis Minor.—It is only in rare circumstances that the dissector will be able to display any of the pelvic lymph vessels, but in favourable subjects he will be able to localise some of the pelvic lymph glands. The main groups of lymph glands of the pelvis are (1) the *hypogastric glands*; (2) the *sacral glands*; and (3) the *rectal glands*. The hypogastric glands are situated on the side walls of the pelvis, near the origins of the branches of the hypogastric arteries. They receive lymph vessels from the membranous part of the urethra, the lower part of the bladder, the prostate, the upper part of the anal canal, and the lower part of the rectum. Their efferent vessels pass to glands situated round the common iliac arteries. The sacral glands lie along the medial sides of the anterior sacral foramina. They receive lymph vessels from the adjacent bones and ligaments, from the rectal glands, and from the prostate. Their efferent vessels end in the common iliac glands. The rectal glands, four or five in number, lie in relation with the superior hæmorrhoidal vein and its two main tributaries. They receive lymph from the rectum, and their efferent vessels terminate in the lateral sacral glands.

Dissection.—As soon as the examination of the pelvic vessels is completed the viscera should be drawn as far as possible from the side wall of the pelvis, and any vessels which tend to prevent the movement should be divided; then the pelvic diaphragm should be examined. It is composed of two muscles on each side, viz.—the levator ani and the coccygeus. Both the muscles must be cleaned, and whilst that is being done care must be taken to avoid injuring the fifth sacral and the coccygeal nerves as they pierce the coccygeus near the coccyx.

Mm. Levatores Ani.—The two levatores ani muscles are strong sheets of muscle fibres, which form the anterior and greater part of the pelvic diaphragm. Each has a triple origin. The anterior fibres arise from the back of the pubic bone, between the attachments of the visceral and parietal layers of the endo-pelvic fascia; the posterior fibres arise

from the pelvic surface of the ischial spine; the intermediate fibres, constituting the greater part of the muscle, take origin in the angle between the visceral and parietal layers of the pelvic fascia.

Insertion.—The *anterior fibres* pass downwards and backwards. A few of them are inserted into the central point of the perineum; others are inserted into the wall of the anal canal, between the internal and external sphincters; and some join with the *intermediate fibres*, which sweep round into the angle between the posterior wall of the rectum and the upper end of the anal canal, where they unite with their fellows of the opposite side and form a strong muscular collar round the gut; the lower fibres of this group are inserted into the posterior wall of the anal canal between the two sphincters. The *posterior fibres* pass backwards and medially, and are inserted into the median ano-coccygeal raphe, behind the rectum, and into the side of the lower part of the coccyx. The anterior fibres of the muscles of the opposite sides embrace the lateral surfaces of the prostate as they pass backwards, and are frequently called the *levatores prostatæ* (Fig. 214). As the intermediate and posterior fibres pass to their insertions they support the infero-lateral surfaces of the bladder and the lateral walls of the rectum. When the muscle contracts, as a whole, it tends to elevate the pelvic viscera. The fibres inserted into the wall of the anal canal pull that wall upwards over descending fæces, and therefore aid defæcation. The fibres which form the collar-like loop round the angle between the rectum and the anal passage will, on contraction, increase that angle, and tend to prevent the passage of the contents of the rectum into the anal passage.

Mm. Coccygei.—The coccygei muscles are two small triangular sheets of muscle which continue the plane of the pelvic diaphragm posterior to the levator ani. Each *arises* from the pelvic surface of the ischial spine and the adjacent pelvic fascia, and, expanding as it passes medially, it is *inserted* into the margin of the last piece of the sacrum and the anterior surface of the upper part of the coccyx. Its anterior margin is continuous with the levator ani, and its posterior margin is separated from the lower border of the piriformis by the inferior gluteal and pudendal vessels and the sciatic and pudendal nerves, as they pass out of the pelvis.

The Pelvic Nerve Plexuses.—There are three pelvic spinal nerve plexuses, viz., the sacral, the pudendal, and the coccygeal. The former two are situated on the posterior wall of the pelvis in front of the piriformis muscle, and the latter lies on the coccygeus muscle close to the side of the coccyx.

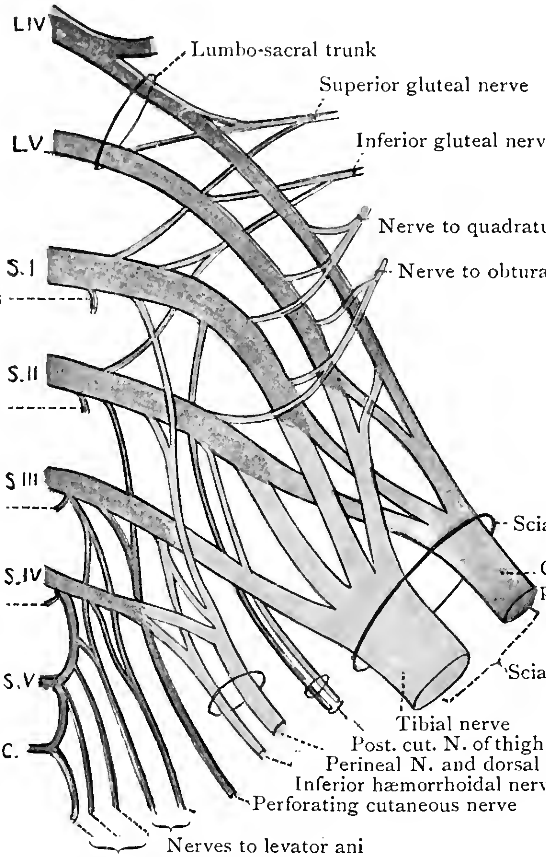

FIG. 217.—Diagram of the Sacral, the Pudendal, and the Coccygeal Plexuses.

The Sacral and Pudendal Plexuses (O.T. Sacral Plexus).—The anterior rami of six spinal nerves take part in the formation of the sacral and pudendal plexuses, viz., part of the fourth lumbar nerve, the fifth lumbar, the first, second, and third sacral nerves, and part of the fourth sacral nerve. The first and second sacral nerves are very large, and of about equal size; the third is much smaller, and the fourth

still smaller. Each of the anterior rami, before it joins the plexus, receives a branch from the nearest sympathetic ganglion, and the third and fourth sacral nerves give white rami communicantes to the sympathetic pelvic plexuses. By the union of the branch of the fourth lumbar nerve with the fifth lumbar nerve, in the abdomen, a *lumbo-sacral trunk* is formed. It descends behind the common iliac artery and across the brim, into the pelvis minor; there it unites with the first sacral nerve to form a loop through which the superior gluteal artery passes. By the union of the other sacral roots a series of similar loops is formed, and the inferior gluteal artery frequently runs through one or other of them before it leaves the pelvis. Beyond the loops the plexuses usually take the form of two flattened bands, viz.—an upper or *sciatic band* and a lower or *pudendal band.* The *sciatic band* is very large, and consists of the lumbo-sacral trunk with the first sacral nerve and the greater portions of the second and third sacral nerves. It runs downwards and laterally, narrowing but thickening as it descends, and, passing first between the adjacent borders of the piriformis and coccygeus, and then through the lower part of the greater sciatic foramen, it leaves the pelvis and enters the buttock as the sciatic nerve (Vol. I. Fig. 129).

The *pudendal band* is small. It consists of fibres of the second, third, and fourth sacral nerves. It passes between the adjacent borders of the piriformis and coccygeus muscles, and it is continued from the pelvis through the lower part of the greater sciatic foramen as the pudendal nerve.

The student who has already dissected the inferior extremity will remember that the sciatic nerve breaks up into common peroneal (O.T. ext. popliteal) and tibial (O.T. int. popliteal) divisions. It occasionally happens that the two divisions arise separately from the sacral plexus. When that is the case there is no sciatic band, and it becomes evident that the common peroneal nerve is derived from the dorsal divisions of the anterior rami of the fourth and fifth lumbar and the first and second sacral nerves, and the tibial nerve, from the ventral divisions of the anterior rami of the same nerves, and also from the ventral division of the anterior ramus of the third sacral nerve. Moreover, when the common peroneal arises directly from the sacral plexus in the manner indicated, it usually perforates the piriformis muscle on its way out of the pelvis.

In addition to the two main bands into which the sacral and pudendal plexuses resolve themselves (sciatic and pudendal) various other branches are given off, some from the back and some from the front of the plexus. They are :—

1. Superior gluteal.
2. Inferior gluteal.
3. Posterior cutaneous of the thigh (O.T. small sciatic).
4. Nerve to the obturator internus and superior gemellus.
5. Nerve to the quadratus femoris and inferior gemellus.
6. Perforating cutaneous nerve.
7. Branches to the piriformis muscle.
8. Branches to the pelvic viscera.

Nervus Glutæus Superior.—The superior gluteal nerve arises from the posterior aspect of the plexus and contains fibres of the fourth and fifth lumbar and first sacral nerves. It passes, with the superior gluteal vessels, above the upper border of the piriformis muscle, and leaves the pelvis through the upper part of the greater sciatic foramen. It is distributed, in the gluteal region, to the glutæus medius and glutæus minimus, and to the tensor fasciæ latæ muscles.

Nervus Glutæus Inferior.—The inferior gluteal nerve is the special branch of supply to the glutæus maximus. It also springs from the back of the plexus; and it contains fibres of the fifth lumbar and the first and second sacral nerves. It passes below the piriformis and through the greater sciatic foramen into the buttock.

Nervus Cutaneus Femoris Posterior (O.T. **Small Sciatic**).—The posterior cutaneous nerve arises from the back of the plexus and contains fibres of the second and third sacral nerves. It passes between the piriformis and coccygeus, and leaves the pelvis through the lower part of the greater sciatic foramen.

The Nerve to the Obturator Internus springs from the anterior aspect of the plexus, and contains fibres of the fifth lumbar and the first and second sacral nerves. It leaves the pelvis with the pudendal nerve, and, after giving a twig to the superior gemellus in the gluteal region, it reaches the obturator internus by passing through the lesser sciatic foramen. It sinks into the medial aspect of the muscle.

The Nerve to the Quadratus Femoris springs from the anterior aspect of the plexus, receiving fibres from the fourth and fifth lumbar and the first sacral nerves. It accompanies the sciatic trunk out of the pelvis, and supplies not only

the quadratus femoris but also the inferior gemellus and the hip joint.

The Perforating Cutaneous Nerve springs from the back of the plexus and contains fibres of the second and third sacral nerves. It leaves the pelvis by piercing the sacro-tuberous ligament, winds round the lower border of the glutæus maximus, and supplies the skin over the lower and medial part of that muscle.

The Twigs to the Piriformis spring usually from the first and second sacral nerves.

The Visceral Branches (white rami communicantes) are derived mainly from the third and fourth sacral nerves.

Plexus Coccygeus.—The coccygeal plexus is a small, looped plexus. It is formed by the lower branch of the fourth sacral nerve, the fifth sacral nerve, and the coccygeal nerve. Besides joining with the fifth, the *fourth sacral nerve* gives branches to the coccygeus and the levator ani, the latter branch being known as the *perineal branch of the fourth sacral.* It also supplies white *rami communicantes* which join the pelvic plexuses of the sympathetic and supply the pelvic viscera.

The *fifth sacral nerve* enters the pelvis by piercing the coccygeus. It communicates with the fourth sacral and the coccygeal nerves and gives branches to the coccygeus muscle.

The *coccygeal nerve* also enters the pelvis by piercing the coccygeus muscle. Having communicated with the fifth sacral nerve it runs downwards and leaves the pelvis by again piercing the coccygeus muscle. It ends in the skin in the neighbourhood of the tip of the coccyx.

Pelvic Plexuses of the Sympathetic.—It has already been noted that the hypogastric plexus, which lies in front of the last lumbar vertebra, ends below by dividing into the two pelvic plexuses. These are prolonged downwards, one on each side of the rectum. Each pelvic plexus receives numerous branches from the third and fourth sacral nerves and from the pelvic portion of the sympathetic trunk of the same side. The points at which the branches of the sacral nerves and the sympathetic trunk unite with the pelvic plexuses are marked by minute ganglia.

Prolongations from each pelvic plexus are sent along the various branches of the hypogastric artery of the same side. There are thus formed various secondary plexuses, viz.—the *hæmorrhoidal* plexus, distributed to the rectum; the *vesical*

plexus, associated with the bladder, the seminal vesicles, and the vas deferens; and the *prostatic* plexus, connected with the prostate. The prostatic plexus proceeds forwards between the prostate and the levator ani, and sends branches, called the *cavernous nerves*, to the penis.

Trunci Sympathici.—The sympathetic trunks reach the pelvis considerably reduced in size. They pass downwards along the medial margins of the anterior sacral foramina, and they end in the median plane, in front of the coccyx, in a minute unpaired ganglion, called the *ganglion impar*. There are generally four ganglia on the pelvic portion of each sympathetic trunk, and each ganglion is connected with one of the sacral nerves by a grey communicating ramus. Some of the branches from the ganglia are distributed to the anterior surface of the sacrum, around the middle sacral artery. From the upper ganglia branches proceed to the pelvic plexuses, and from the ganglion impar branches are given to the parts about the coccyx and to the glomus coccygeum.

Glomus Coccygeum (O.T. **Coccygeal Body**).—This is a lobulated body, about the size of a small pea, which lies in front of the tip of the coccyx. It is composed of masses of polyhedral cells, intermingled with strands of connective tissue, numerous sympathetic nerve twigs, and branches of the middle sacral artery. Its function is unknown.

Dissection.—The vessels and nerves passing to the viscera should be divided and the viscera should be removed, and the structure of the walls of the rectum and bladder should be examined.

Structure of the Rectum.—The rectum possesses the following coats:—1. Serous. 2. Fascial. 3. Muscular. 4. Submucous. 5. Mucous.

The *peritoneal coat*, and the *fascial coat*, derived from the visceral layer of the pelvic fascia, have already been examined.

The Muscular Coats of the Rectum.—The muscular coats of the rectum are strong. They consist of an external longitudinal and an internal circular layer of involuntary or unstriped muscle-fibres. The longitudinal fibres are continuous, above, with the three longitudinal bands of the colon. As the three bands pass downwards the fibres which compose them spread out to form a continuous layer round the rectum.

The layer is not, however, uniformly thick on all aspects of the gut, for in front and on the back the fibres are massed to form two broad bands, which maintain the flexures and prevent the rectum from elongating as it becomes loaded. The circular muscle-fibres form a more or less uniform layer, internal to the longitudinal fibres, and they are prolonged into the bases of the plicæ transversales.

Muscular Coat of the Anal Canal.—The muscular wall of the anal canal is very thick and powerful. The internal circular layer of muscle-fibres, prolonged down from the rectum, is greatly thickened to form a muscular cylinder, the *internal sphincter*, which embraces the whole length of the canal, except the lower 12.5 mm. (half-inch). The longitudinal fibres from the rectum are also prolonged downwards, outside the internal sphincter, and they blend with the fibres of the levator ani, which are inserted into the wall of the canal between the internal and the external sphincters. The external sphincter surrounds the lower part of the canal outside the levator ani.

Submucous Coat of the Rectum and Anal Canal.—The submucous coat is composed of lax areolar tissue, which allows the mucous coat to move freely on the muscular coat. It contains vessels and nerves.

Mucous Membrane of the Rectum and Anal Canal.—The mucous membrane of the rectum and anal canal is thicker and more movable upon the muscular tunic than the mucous membrane of the colon, and, in consequence of its mobility, it is thrown into irregular folds or rugæ when the gut is empty. In the upper part of the anal canal the mucous membrane is thrown into a series of longitudinal folds, called *columnæ rectales* (Morgagni). A short distance above the anal orifice the columns are connected by a number of irregular semilunar folds, called the *anal valves.* In the concavity of each valve is a pocket-like recess, termed a *sinus rectalis.* The folds are of importance in connection with the condition known as fissured anus, and they indicate the level at which the scaly epithelium of the integument merges into the columnar epithelium of the gut.

Plicæ Transversales Recti (O.T. **Valves of Houston**).—The transverse folds of the rectum are not always visible, and are usually seen best in a rectum which has been fixed with formalin when in a state of distension. They are three in number, in conformity with the inflections of the gut;

consequently there are two on the left side and one, the largest, on the right side. Each is formed by an infolding of the mucous, submucous, and part of the muscular coat. The positions of the folds are variable; but the right and largest is usually placed at the level of the bottom of the recto-vesical excavation of peritoneum, whilst the two folds of the left side are situated, one 38 mm. (an inch and a half) above the right fold, and the other the same distance below it (Birmingham).

The Structure of the Walls of the Bladder.—The bladder possesses the following five coats:—

1. Serous. 2. Subserous. 3. Muscular. 4. Submucous. 5. Mucous.

The *serous* or *peritoneal covering* has already been examined. The *subserous coat* is a thin stratum of areolar tissue which connects the peritoneum with the muscular coat.

The Muscular Coat.—The fibres of the muscular wall of the bladder are arranged in three layers:—

1. External longitudinal fibres. 2. Circular fibres. 3. Internal longitudinal fibres.

The *external longitudinal fibres*, frequently spoken of as the *detrusor urinæ*, spring from the back of the pubic bones, the pubo-prostatic ligaments, and the base of the prostate. They ascend from those attachments over the anterior border and the medial parts of the infero-lateral surfaces of the bladder. At the apex a few pass into the urachus, but the majority pass backwards over the superior surface and the base of the bladder to the prostate, to which they are attached. On the lateral parts of the infero-lateral surfaces and on the lateral borders of the bladder, the longitudinal layer is less complete, and the fibres take a more oblique direction.

The *circular fibres* are arranged in coarse bundles which run obliquely as well as circularly round the bladder, and constitute the greater part of its muscular coat. At the internal urethral orifice the bundles become finer and are massed together to form a sphincter, the fibres of which are more or less continuous with those of the prostate.

The *internal longitudinal fibres* are absent on the fundus, and form only an incomplete layer on the other walls of the bladder.

The Submucous Coat.—The submucous coat is a layer

of areolar tissue which forms a loose connection between the mucous and muscular coats, except in the region of the trigone, where the connection is much closer. The blood-vessels and nerves ramify in the submucous layer before they enter the mucous coat.

The Mucous Coat.—*The mucous coat* has already been examined (p. 425). When the bladder is distended it is smooth in all areas, but when the bladder is empty or partially empty it is smooth in the area of the trigone only. In all other parts it is thrown into a series of irregular folds (Fig. 200).

Dissection.—**Remove the levator ani, leaving small portions attached to its bony origins, viz., the body of the pubis and the spine of the ischium. Take away all the remains of the parietal pelvic fascia from the side wall of the pelvis, and the obturator internus muscle will be exposed.**

M. Obturator Internus.—The internal obturator muscle clothes the side wall of the pelvis on its inner aspect. It is fan-shaped and takes an extensive origin, viz.—(1) from the circumference of the obturator foramen, except above, where the obturator vessels and nerves quit the pelvis; (2) from the pelvic surface of the obturator membrane; (3) from the surface of bone behind the obturator foramen, as far back as the greater sciatic notch. A few fibres are derived also from the parietal pelvic fascia which covers it. From these origins the fibres converge towards the lesser sciatic notch, and end in a tendon which issues from the pelvis through the lesser sciatic foramen. In the gluteal region the tendon is inserted, together with the two gemelli, into the medial margin of the upper border of the greater trochanter of the femur. The margin of the lesser sciatic notch over which the tendon glides is coated with smooth cartilage, which is raised into three or four parallel ridges; the ridges fit into fissures in the deep surface of the tendon. A mucous bursa intervenes between the tendon and the cartilage.

The obturator internus is supplied by a special branch from the front of the upper part of the sacral plexus (p. 463). In the erect posture it is a lateral rotator of the femur, but when the hip joint is flexed it is an abductor of the femur.

M. Piriformis.—The piriformis lies on the anterior aspect of the posterior pelvic wall. It *arises* by three processes from the anterior surface of the sacrum, in the region

of the second, third, and fourth sacral segments, between and lateral to the foramina and, to a slight extent, medial to the foramina; it takes origin also from the upper border of the greater sciatic notch and from the sacro-tuberous ligament. The muscle leaves the pelvis through the upper part of the greater sciatic foramen, and is *inserted*, by a rounded tendon, into the middle of the upper border of the greater trochanter of the femur. It is supplied by branches from the first and second sacral nerves. Its actions are the same as those of the obturator internus.

Ligamenta Cinguli Extremitatis Inferioris (Ligaments of the Pelvic Articulations).

The pelvis is attached to the last lumbar vertebra at the lumbo-sacral articulation, and its several parts are held together by the following articulations:—(1) Sacro-coccygeal; (2) Coccygeal; (3) Sacro-iliac; (4) Pubic.

Dissection.—The nerves and blood-vessels of the pelvis, and all adhering portions of muscle, must now be removed from the hip bone and from the front and back of the sacrum. When that has been done the pelvis should be soaked for some time in warm water, a proceeding which will render the dissection of the ligaments much easier.

Lumbo-sacral Articulations. — The last lumbar vertebra is joined to the sacrum by one *synchondrosis*, which connects the body of the vertebra to the base of the sacrum, and by two *diarthrodial joints*, between the two pairs of articular processes.

Articular capsules, consisting of a fibrous stratum lined with a synovial stratum, surround the articulations formed by the apposition of the articular processes.

Ligamenta Longitudinalia (O.T. *Anterior and Posterior Common Ligaments*).—The anterior longitudinal ligament of the vertebral column is continued downwards, over the anterior aspect of the body of the last lumbar vertebra, to the anterior aspect of the first segment of the sacrum. In a similar manner the posterior longitudinal ligament is prolonged downwards, within the vertebral canal, over the posterior aspect of the body of the last lumbar vertebra, to the upper part of that portion of the sacrum which forms the anterior wall of the sacral canal.

Ligamenta Flava (O.T. *Ligamenta Subflava*) also are present. They are two short bands of yellow elastic tissue, placed one on each side of the median plane. Superiorly, they are attached to the anterior aspect of the lower borders of the laminæ of the last lumbar vertebra; whilst, inferiorly, they are fixed to the posterior aspect of the upper margins of the laminæ of the first sacral segment.

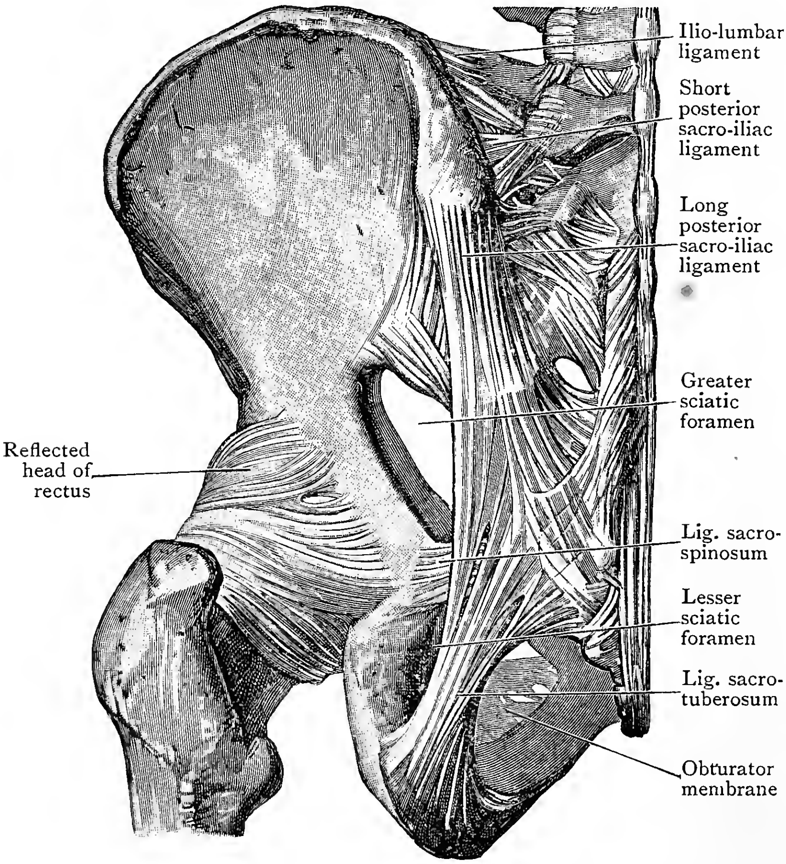

FIG. 218.—Posterior view of the Pelvic Ligaments and of the Hip Joint.

Ligamentum Interspinale.—An interspinous ligament connects the lower border of the spinous process of the last lumbar vertebra with the upper border of the spinous process of the first sacral vertebra. A *ligamentum supraspinale* passes between the extremities of the same spinous processes.

So far, then, the ligaments of the lumbo-sacral articulations are identical with those which, above the level of the sacrum,

bind the several segments of the vertebral column together. Two additional ligaments, on each side, viz., the lumbo-sacral and the ilio-lumbar, must now be examined.

The *lumbo-sacral ligaments* are the representatives of the anterior costo-transverse ligaments. Each is a strong, triangular, fibrous band, attached by its apex to the tip and lower border of the transverse process of the last lumbar vertebra. Expanding as it proceeds downwards, it is fixed below to the posterior part of the base of the sacrum, where some of its fibres intermingle with those of the sacro-iliac ligaments.

Ligamenta Iliolumbalia.—Each *ilio-lumbar ligament* may be considered a thickened and specially developed part of the anterior lamella of the lumbar fascia of the corresponding side, for it lies in the same plane as the fascia and is directly continuous with it. It is triangular in shape, and is fixed by its apex to the tip of the transverse process of the last lumbar vertebra. Proceeding horizontally and laterally, it is inserted into the internal lip of the iliac crest, at the posterior part of the iliac fossa.

The *synchondrosis* between the body of the last lumbar vertebra and the base of the sacrum corresponds, in every respect, to the similar articulations between the bodies of the vertebræ above. The opposed bony surfaces are each coated with a thin layer of hyaline cartilage, and are firmly united by an intervening disc of fibro-cartilage, which is dense and laminated externally, but soft and pulpy towards the centre. The dissector should note that the disc is the thickest of the series, and further, that it is wedge-shaped, being thicker in front than behind.

Sacro-coccygeal Articulations.—The sacro-coccygeal articulations are (1) a synchondrosis between the bodies of the last sacral and the first coccygeal vertebra, and (2) a pair of syndesmoses between the sacral and coccygeal cornua. In the synchondrosis between the bodies of the last sacral and the first coccygeal vertebra each of the articulating surfaces is covered with a thin cartilaginous plate, and the cartilage plates are united by a disc of fibro-cartilage. The joint is strengthened in front by an *anterior ligament*, which extends downwards from the front of the sacrum to the anterior aspect of the coccyx, and by a *posterior ligament*, which, attached above to the posterior border of the lower aperture of the

sacral canal, proceeds downwards upon the posterior aspect of the coccyx. The posterior ligament is much the stronger of the two. The sacral and coccygeal cornua are united by fibrous bands. Other fibrous bands connect the lateral angles of the sacrum and the transverse processes of the first piece of the coccyx.

As regards the *coccygeal joints* (when such exist), the union of the different segments of the bone is brought about by intervening fibro-cartilaginous discs and anterior and posterior ligaments.

Sacro-iliac Articulation.—The sacrum is wedged in between the two hip bones, and is held fast in that position by the sinuous form of the opposed articular surfaces, and by the strong ligaments which pass between the bones. The ligaments are:—

1. Anterior sacro-iliac.
2. Posterior sacro-iliac.
   (*a*) Long posterior sacro-iliac.
   (*b*) Short posterior sacro-iliac.
   (*c*) Interosseous sacro-iliac.
3. Sacro-tuberous.
4. Sacro-spinous.

Ligamentum Sacroiliacum Anterius.—The anterior sacro-iliac ligament is by no means strong. It is composed of a series of short fibres stretching across the front of the joint, and connecting the bones anteriorly.

Ligamentum Sacroiliacum Posterius Longum.—The *long posterior sacro-iliac ligament* is fixed, above, to the posterior superior spine of the ilium; whilst, inferiorly, it is inserted into the third tubercle on the posterior surface of the lateral mass of the sacrum. It lies posterior to the inter-osseous ligament.

Ligamentum Sacroiliacum Posterius Breve.—The short posterior sacro-iliac ligament also lies behind the interosseous ligament, and is a short band of fibres which extends from the posterior superior spine of the ilium to the back of the sacrum.

Ligamentum Sacroiliacum Interosseum.—The *interosseous sacro-iliac ligament* is exceedingly strong. It consists of fibrous bands which connect the rough surface on the lateral part of the posterior aspect of the sacrum with a corresponding rough surface on the ilium, behind the auricular surface. Upon the interosseus sacro-iliac ligaments the strength of the articulation chiefly depends. Since the sacrum narrows towards its

dorsal surface it cannot be regarded as forming a typical keystone of an arch. On the contrary, it is suspended from the iliac bones by the posterior sacro-iliac ligaments.

Ligamentum Sacrotuberosum (O.T. *Great Sacro-sciatic Ligament*).—The sacro-tuberous ligament has a wide attachment to the posterior superior and posterior inferior iliac spines and to the side of the sacrum and coccyx. As it passes downwards and forwards it narrows and thickens, but before reaching its termination it again expands. It is inserted into the medial border of the tuberosity of the ischium. Thence

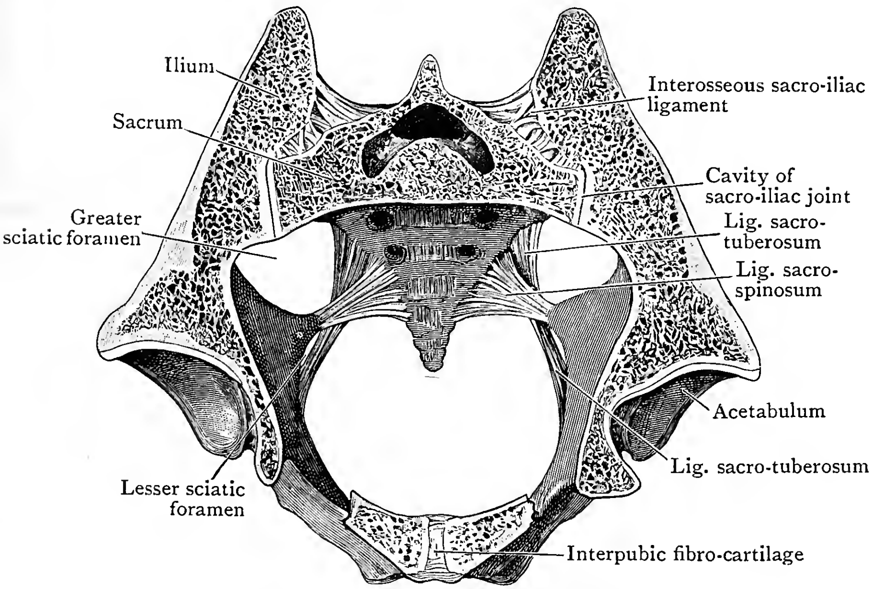

FIG. 219.—Frontal section through the Pelvis.

it sends a sharp *falciform process* forwards for a short distance upon the inferior ramus of the ischium, and gives attachment to the parietal pelvic fascia. It should be noticed that at its ischial attachment some of the fibres of the ligament pass directly into the tendon of the biceps femoris muscle.

Ligamentum Sacrospinosum (O.T. *Small Sacro-sciatic Ligament*).—The sacro-spinous ligament is triangular in form. By its base it is fixed to the side of the sacrum and coccyx, in front of the sacro-tuberous ligament, the fibres of both mingling together; by its apex it is attached to the spine of the ischium. The pelvic surface of this ligament presents an extremely intimate connection with the coccygeus muscle;

indeed, it is generally believed that the ligament is derived from the posterior part of the muscle by the fibrous degeneration of the muscular fasciculi.

The sacro-tuberous and the sacro-spinous ligaments convert the sciatic notches of the hip bone into foramina.

Through the *greater sciatic foramen* pass the superior gluteal vessels and nerve, the piriformis muscle, the pudendal and inferior gluteal vessels and nerves, the nerve to the obturator internus, the sciatic nerve, the nerve to the quadratus femoris, and the posterior cutaneous nerve of the thigh.

The *lesser sciatic foramen* transmits the tendon of the obturator internus muscle, the pudendal vessels and nerve, and the nerve to the obturator internus muscle.

The sacro-iliac joint is a diarthrodial joint. The ligaments of the joint should now be divided, and the two bones forcibly wrenched asunder. It will then be seen that each articular surface is covered with a plate of cartilage, and that a small synovial space intervenes between and partially separates the two plates.

The sacro-iliac joint is not immovable. A slight amount of movement can take place—the sacrum rotating round an imaginary line drawn transversely through its second piece. In the erect posture the promontory of the sacrum is withdrawn to the full extent from the symphysis; when the body is bent forwards, the symphysis and the promontory are approximated, and, in consequence, the tension of the sacro-tuberous and sacro-spinous ligaments is increased.

Symphysis Ossium Pubis.—The symphysis pubis is an example of a synchondrosis. In addition to the intervening disc of fibro-cartilage which connects the cartilage-covered opposing surfaces of the two pubic bones, *four* ligaments are present, viz. :—

1. Anterior pubic. 2. Posterior pubic. 3. Superior pubic. 4. Arcuate.

Ligamentum Pubicum Anterius.—The *anterior pubic ligament* is strongly marked, and consists of two layers of fibres—a superficial and a deep. The *superficial fibres* are oblique, and cross each other like the limbs of the letter X, mingling with the decussating fibres of the superior crura of the subcutaneous inguinal rings. The *deep fibres* are transverse and extend across from one bone to the other.

Ligamentum Pubicum Posterius.—The *posterior pubic liga-*

ment consists of a very few transverse fibres on the pelvic aspect of the joint.

Ligamentum Pubicum Superius.—The *superior pubic ligament*, like the preceding, is weak. It is placed upon the upper aspect of the symphysis, and stretches between the crests of the two pubic bones.

Ligamentum Arcuatum Pubis (O.T. *Sub-pubic Ligament*).—*The arcuate pubic ligament* is situated on the lower aspect of the joint, and it rounds off the apex of the pubic arch. It is a strong band, somewhat triangular in shape, which is attached, on each side, to the inferior ramus of the pubic bone, and above, to the fibro-cartilaginous disc. Between the crescentic lower margin of this ligament and the upper border of the urogenital diaphragm there is an oval aperture through which the dorsal vein of the penis passes backwards.

Dissection.—The saw should now be used, and a portion sliced off from the front of the interpubic joint. The intervening plate of fibro-cartilage can in this way be studied. It will be seen to be thicker and denser in front than behind. As a general rule, a small synovial cavity will be found towards its posterior part, and nearer its upper than its lower end.

Membrana Obturatoria (O.T. **Thyroid Membrane**).—The obturator membrane stretches across the obturator foramen. It is attached to the circumference of the foramen, except at its upper part, where it bridges across the groove on the inferior surface of the superior ramus of the pubic bone, and converts it into a canal for the escape of the obturator vessels and nerve. At that point it is continuous, over the upper border of the obturator internus muscle, with the parietal pelvic fascia.

Female Pelvis Minor.

The contents of the female pelvis are the following :—

Viscera.
- The pelvic colon and rectum.[1]
- The urinary bladder, the urethra, and the ureters.[1]
- The uterus and vagina.[1]
- The uterine appendages.
  - Uterine tubes.
  - Ovaries.
  - Round ligaments.

[1] Strictly speaking, the urinary bladder and urethra, the vagina and the lower part of the rectum, lie in the visceral layer of the pelvic fascia.

Blood-vessels.
- The hypogastric vessels and their branches.
- The superior hæmorrhoidal vessels.
- The ovarian vessels.
- Certain venous plexuses in relation with the viscera.

Nerves.
- The obturator nerves.
- The pelvic plexuses of the sympathetic and their offsets.

Peritoneum and extra-peritoneal fat.

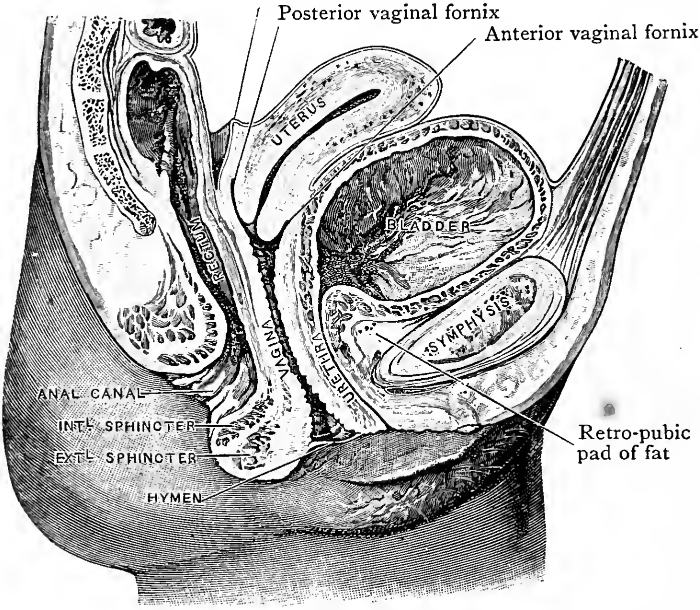

FIG. 220.—Median section through Female Pelvis.

The following structures lie in the wall of the pelvis minor, outside the pelvic fascia :—

Blood-vessels.
- The middle sacral vessels.
- The parietal branches of the hypogastric vessels after they have pierced the fascia.

Nerves.
- The sacral, pudendal, and coccygeal plexuses.
- The pelvic parts of the sympathetic trunks.

General Position of the Viscera.—The *pelvic colon* lies in the posterior and upper part of the cavity, and its loops tend to overlap the other viscera. The *rectum* occupies the posterior and lower part of the cavity, and is adapted to the concavity of the sacrum and coccyx. The *urinary bladder* and *urethra* are situated in front, the former lying against the bodies of the pubic bones. The *uterus* and *vagina* occupy an intermediate position between the urinary bladder and

the rectum; and the *uterine appendages* lie laterally between the uterus and the side walls of the pelvis minor.

Peritoneum. — As the peritoneum descends from the posterior abdominal wall into the pelvis, it gives a complete covering to the pelvic colon and attaches it to the anterior surface of the sacrum by a pelvic meso-colon. At a lower level it gives a partial covering to the rectum, first clothing it on its anterior and lateral surfaces, then on its anterior surface alone. Finally, it quits the gut about 7 cm. (three inches) above the level of the anus, and is reflected on to the upper part of the posterior wall of the vagina (Fig. 220), upon which it ascends to the uterus. It covers the whole of the supra-vaginal portion of the posterior surface of the uterus, the fundus or upper extremity, and the upper two-thirds of the anterior surface of the uterus; then it is reflected on to the fundus of the bladder. As the peritoneum passes forwards from the uterus to the bladder it forms two slightly marked folds, one on each side, which are called the vesico-uterine folds. The vagina, therefore, receives a partial covering of peritoneum posteriorly, but is altogether devoid of peritoneum anteriorly. The whole of the supra-vaginal portion of the posterior surface of the uterus is covered, but only the upper two-thirds of the anterior surface. From each lateral border of the uterus the peritoneum extends laterally in the form of a wing-like fold, the *broad ligament*, which connects the uterus with the side wall of the pelvis.

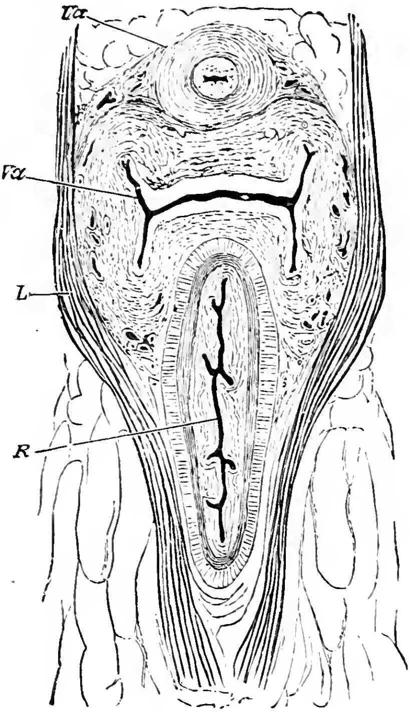

FIG. 221.—Horizontal section through the Urethra, Vagina, and Anal Canal, a short distance above their terminations. (Henle.)

Ua. Urethra. | *L.* Levator ani.
Va. Vagina. | *R.* Rectum.

From the upper surface of the bladder the peritoneum

is conducted upwards to the posterior surface of the anterior abdominal wall by the middle umbilical ligament, over which it forms a fold known as the *median umbilical fold.* From each lateral border of the upper surface of the bladder the peritoneum extends laterally to the side wall of the pelvis, forming the *lateral false ligaments of the bladder.*

Ligamenta Lata Uteri (Broad Ligaments of the Uterus).—Each broad ligament is a wide fold composed of two layers of peritoneum. It stretches from the lateral border of the uterus to the side wall of the pelvis, and may be said to possess superior, inferior, medial and lateral borders, and

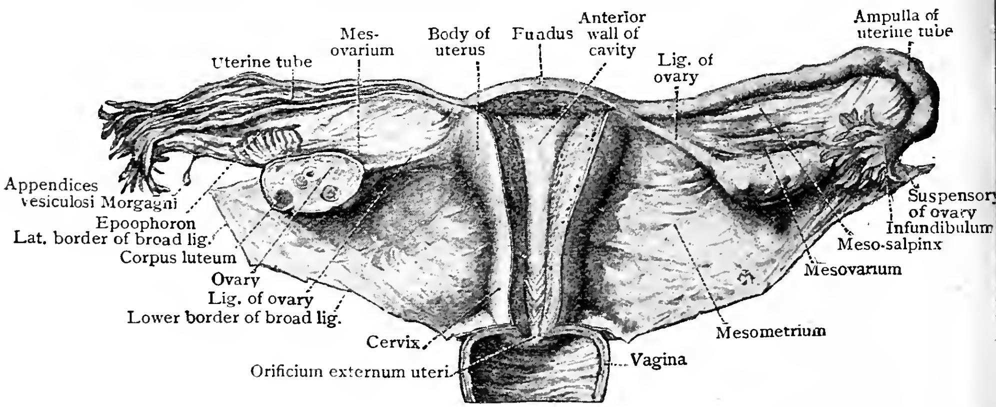

FIG. 222.—The Uterus, the Uterine Tubes, the Ovaries, the Broad Ligaments, and the upper part of the Vagina, seen from behind. The posterior wall of the uterine cavity has been removed, and the left Uterine Tube and the upper part of the Vagina have been opened.

anterior and posterior surfaces. The *superior border* is free, and, in the greater part of its extent, it encloses the uterine tube. The smaller lateral part of the superior border which extends beyond the uterine tube is called the *suspensory ligament* of the ovary; it contains the ovarian vessels and nerves. The *inferior border or base* rests, medially, on the upper end of the vagina and, laterally, on the levator ani. At the lower border, the anterior layer of the peritoneal fold is reflected forwards, to become continuous with the lateral false ligament of the bladder, and the posterior layer passes backward into the floor of the genital or middle pelvic fossa. The *lateral border* of the ligament is attached to the side wall of the pelvis, a short distance in front of

the hypogastric artery. The *medial border* is attached to the side of the uterus.

Two secondary folds spring from the broad ligament, one from each surface. The one from the posterior surface contains the *ovary and its ligament*, and the one from the

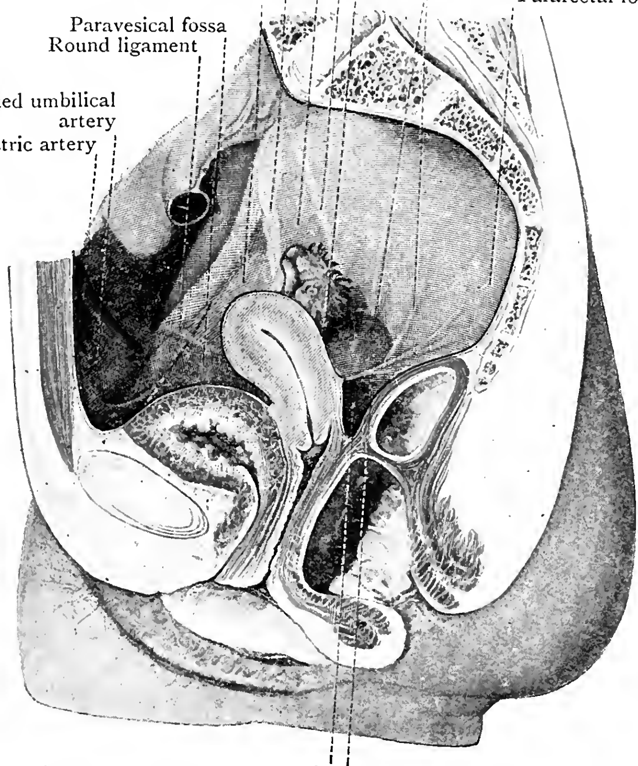

FIG. 223.—Median section through the Female Pelvis to show the disposition of the Peritoneum in relation to the Viscera and to the Side Wall of the Cavity. (Dixon and Birmingham.)

anterior surface contains the *round ligament of the uterus*. The portion of the broad ligament between the uterine tube and the ovary is termed the *mesosalpinx*. The fold which proceeds from the posterior surface of the ligament to the ovary is the *mesovarium*, and the portion of the broad ligament below the level of the mesovarium is sometimes called the *mesometrium*. In addition to the uterine tube, the ovary and its ligament,

and the round ligament of the uterus, the two layers of the broad ligament include between them other structures, viz., (1) the *epoophoron*; (2) the *uterine* and *ovarian blood-vessels* and *nerves* and lymph vessels.

Peritoneal Fossæ.—The paravesical fossæ lie in front of the broad ligament, at the sides of the urinary bladder.

Each middle or genital fossa is bounded *anteriorly* by the back of the broad ligament and a ridge, called the ureteral ridge because it is caused by the projection of the ureter, and *posteriorly* by a fold of peritoneum, called the *utero-sacral fold*, which is similar to the sacro-genital fold of the male (p. 412). Each utero-sacral fold is semilunar in form, and curves from the back of the uterus to the posterior wall of the pelvis, at the side of the rectum. Between its two layers there are some unstriped muscular fibres as well as connective tissue. The two folds meet across the back of the uterus, where they form a projection known as the *torus uterinus.*

The pararectal fossæ are situated at the sides of the empty rectum, between it and the utero-sacral fold.

Excavatio Recto-uterina (O.T. **Pouch of Douglas**).—The recto-uterine pouch corresponds to the recto-genital pouch or recto-vesical excavation in the male. *Anteriorly*, it is bounded by the peritoneum covering the upper part of the posterior wall of the vagina and the lower part of the back of the uterus; *posteriorly*, by the peritoneum on the rectum; while *on each side* is the utero-sacral fold of peritoneum. It is continuous with the pararectal fossæ, which are obliterated when the rectum is distended (p. 413).

Excavatio Vesico-uterina.—The vesico-uterine pouch is a shallow depression, not always distinguishable, between the uterus and the upper part of the base of the urinary bladder. It is bounded laterally by two slight folds of peritoneum termed the *utero-vesical folds.*

Dissection.—The dissector should cut through the lateral false ligaments of the urinary bladder at their junctions with the lower borders of the anterior surfaces of the broad ligaments: he should then reflect the lateral false ligaments medially to the lateral borders of the upper surface of the urinary bladder. Next, he should draw the apex of the bladder backwards and pass his index finger down through the soft fat, between the anterior border of the bladder and the back of the symphysis pubis, till he feels the resistance of the upper fascia of the pelvic diaphragm, which passes medially from the wall of the pelvis to the bladder, and which is thickened on each side of the median

plane to form the *medial pubo-vesical ligaments.* Those ligaments having been recognised, the finger should be carried laterally and then backwards between the wall of the pelvis and the urinary bladder as far as the lateral border of the broad ligament. The dissector will find he can do this quite easily, and by doing it he will demonstrate the fact that between the anterior border and infero-lateral surfaces of the bladder and the wall of the pelvis there is a space filled with easily displaced extra-peritoneal fat; it is the lower and anterior part of the so-called *cave of Retzius,* and it is bounded below by a layer of fascia called the visceral pelvic fascia which extends from the side wall of the pelvis to the pelvic viscera. The finger should now be passed still farther backwards along the side wall of the pelvis, beyond the lateral border of the broad ligament, until the front of the hypogastric artery is reached; but little resistance will be met, and the dissector will be able to satisfy himself that the lower part of the so-called cave extends round the sides and front of the pelvis from the hypogastric artery of one side to the corresponding vessel of the opposite side. The upper part of the cave lies behind the anterior abdominal wall, extending upwards between the inferior epigastric arteries to the level of the umbilicus. The cave is of practical importance, because, on account of the laxity of its fatty contents, urine escaping from a ruptured urinary bladder, or effused blood, or inflammatory exudations, can spread rapidly throughout the area; moreover, it is an area in which the surgeon can readily separate the pelvic contents from the pelvic wall. Having satisfied himself as to the presence and the boundaries of the cave, the dissector should carefully remove the extra-peritoneal fat which lies between the urinary bladder and the wall of the pelvis minor, taking care to avoid injuring any vessels which may be passing through the fat. When he has completed this part of the dissection he will have displayed on the side wall of the pelvis the following structures:—The obliterated umbilical artery, lying a short distance below the level of the pelvic brim; the obturator nerve, below the ligament; and, at a still lower level, the obturator artery and vein. Passing from the umbilical artery to the bladder, the superior vesical artery will be found. Lateral to the obturator vessels and nerve, the parietal pelvic fascia will be seen; and at the bottom of the space he will find the visceral layer of the pelvic fascia passing medially from the parietal layer to the bladder. Just to the lateral side of the junction of the lateral border with the posterior border of the urinary bladder he will find the lower end of the ureter, and, if he passes a finger into the vagina, he will recognise that the lower end of the ureter is crossing a recess of the vagina, at the side of the lower end of the uterus, which is called the *lateral fornix* of the vagina (Fig. 228). If the lower border of the broad ligament is now carefully raised, the uterine artery will be found passing medially above the ureter to the side of the uterus (Fig. 227).

Having displayed the structures in front of the broad ligament, the dissector should turn to the posterior part of the pelvis, where he must carefully divide the peritoneum along the back of the lower border of the broad ligament, and then turn the membrane behind the incision medially from the side

wall of the pelvis minor to the rectum. When that has been done and the extra-peritoneal fat has been dissected away, the ureter, the divisions and branches of the hypogastric artery, the accompanying veins, and the pelvic plexuses of the sympathetic nerves passing forwards at the sides of the rectum, will be exposed. Whilst this stage of the dissection is proceeding care must be taken to avoid injuring the parietal or the visceral pelvic fascia. The hypogastric vessels lie inside the fascia, and their visceral branches pierce the visceral layer, whilst the parietal branches pierce the parietal layer. The main nerve trunks and the trunks of the sympathetic are outside the parietal fascia; therefore their branches do not pierce the fascia as they pass out of the pelvis. The obturator nerve, however, pierces the parietal pelvic fascia, from without inwards, at the posterior part of the pelvis, and runs forwards, lateral to the hypogastric vessels and below the pelvic brim, to the upper part of the obturator foramen, where it enters the obturator canal, through which it passes into the thigh.

When the extra-peritoneal fat has been removed, the general positions of the structures behind the broad ligament should be noted (Figs. 224, 225). The hypogastric artery serves as a prominent landmark as it descends at the junction of the side wall with the posterior wall of the pelvis. In front of the hypogastric artery the ureter runs downwards till it reaches the level of the visceral layer of the pelvic fascia; then it turns forwards and medially to the corresponding posterior angle of the bladder. As it runs forwards and medially it passes beneath the lower border of the broad ligament and the uterine artery, and obliquely above and in front of the upper end of the vagina.

The student should verify the important relations of the ureter to the vagina and to the uterus by passing a finger into the vagina, and noting that when the tip of his finger lies at the top of the vagina and at the side of the lower end of the uterus, it is immediately below the medial part of the lower border of the broad ligament, and that the ureter passes obliquely, from behind forwards and medially, across it.

Running forwards on the side wall of the pelvis, and passing to the lateral side of the ureter, will be found the obliterated umbilical artery and the obturator nerve and vessels. In the female, the obliterated umbilical artery is frequently below the level of the obturator nerve behind the broad ligament, but it rises above the nerve as it passes forwards. The uterine artery will be found descending in front of the ureter, before it turns medially to cross above the duct, beneath the lower border of the broad ligament.

The hypogastric vein lies behind the stem of the hypogastric artery, and frequently conceals its posterior division.

Endo-Pelvic Fascia.—The fascia of the pelvis minor should now be examined. It is a strong membranous layer

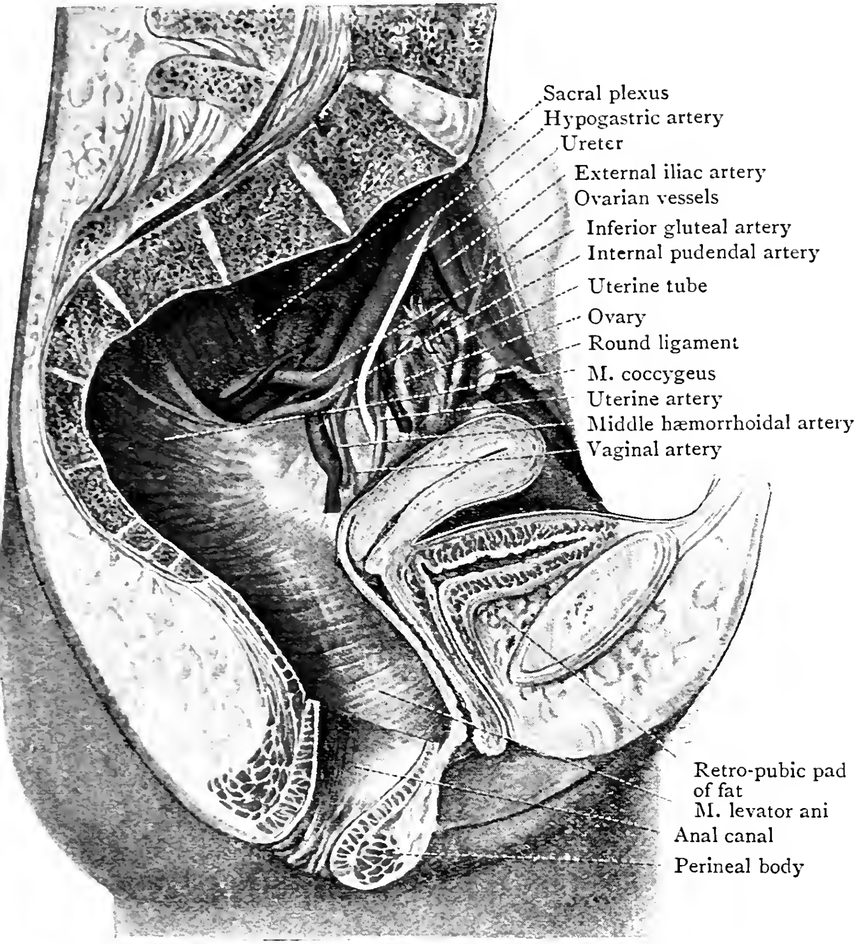

FIG. 224.—Dissection of a median section of a Female Pelvis, showing the Pelvic Diaphragm and the structures on the side wall of the Pelvis behind the Broad Ligament.

which is separable into two parts—a *parietal portion* which forms one of the strata of the walls of the pelvis; and a *visceral portion*, consisting of the upper fascia of the pelvic diaphragm, which forms part of the pelvic floor, and lies upon the muscular diaphragm which separates the pelvis proper from the perineum. The parietal layer passes down below

the level of the visceral layer into the perineum, where it is still spoken of as parietal pelvic fascia. The dissector should commence his examination of the fascia by noting that the parietal part is continuous above with the fascia on the psoas major muscle. Traced downwards from the psoas, it can be followed to the level of a line extending from the lower part of the back of the symphysis to the spine of the ischium, *i.e.*, to the level at which the visceral layer springs from its inner surface. Traced backwards, it passes lateral to the hypogastric vessels and then across the front of the sacrum to the opposite side, concealing the sacral plexuses and the piriformes muscles.

When it is traced forwards it will be found to terminate, anteriorly, along a curved line which commences at the medial side of the ilio-pectineal eminence, on the inner surface of the superior ramus of the pubis, descends to the lower border of the symphysis pubis, and then ascends to a corresponding point on the opposite side. The parietal fascia is deficient, therefore, on the anterior boundary of the lower part of the cave of Retzius. Each half of this anterior border of the parietal fascia is separable into three parts: A lateral part, where the fascia blends with the periosteum on the pelvic surface of the superior ramus of the pubis; an intermediate part, below the highest portion of the obturator foramen, where the fascia turns over the upper border of the obturator internus and runs outwards into the thigh, forming the lower wall of the obturator canal; a medial part, which is attached to the periosteum on the pelvic surface of the body of the pubis.

Turning next to the visceral layer, the dissector will find as he traces it medially, in the posterior part of the pelvis, that the rectum sinks into its substance. In front of the rectum it is carried over the upper part of the vagina on to the uterus, and in front of the uterus it is lost on the urinary bladder. Still more anteriorly, it can be followed across the median plane to the opposite side. In this last part of its extent two thickened bands of its substance, one on each side of the median plane, extend from the back of the pubis to the anterior border of the bladder. Those bands are the medial pubo-vesical ligaments or anterior true ligaments of the bladder, already referred to. The dissector should note that the attachment of the visceral layer to the back of the body of the pubis lies at a higher level than the attachment of the anterior border

of the parietal layer. In the space between the two lines of attachment, on each side, the anterior fibres of the corresponding levator ani arise from the back of the body of the pubis.

The dissector should now turn to the perineum and examine the pelvic fascia from below. He has already seen that it forms the lateral wall of the ischio-rectal fossa and is carried medially from the margin of the pubic arch, as the superior fascia of the urogenital diaphragm, to the median plane, where it turns backwards along the urethra and round the anterior border of the levator ani.

He has seen also that the levator ani arises from the parietal fascia of the lateral wall of the ischio-rectal fossa and passes downwards and medially to the wall of the anal canal, into which many of its fibres are inserted. The levator ani must now be divided from before backwards, midway between its origin and its insertion, and the upper portion must be turned towards the pelvic wall. When that has been done, the lower surface of the superior fascia of the pelvic diaphragm will be exposed, and the dissector will see, after the removal of the peritoneum and extraperitoneal fat above, and the levator ani below, that now the visceral fascia alone separates the pelvic cavity above from the perineum below, and he can convince himself that the visceral layer springs from the parietal layer immediately above the origin of the levator ani, and that, as it runs towards the median plane, it encloses the pelvic viscera. He will find also, if he traces the inferior surface of the visceral layer forwards, that it blends anteriorly, round the anterior border of the levator ani, with the upper fascia of the urogenital diaphragm, which is formed by the parietal layer of the pelvic fascia. He has still to demonstrate the cleavage of the visceral layer into secondary lamellæ which ensheathe the pelvic viscera. To do this he must take the following steps :—

Dissection.—Detach the crura of the clitoris from the margins of the pubic arch and trace the dorsal vein of the clitoris beneath the arcuate ligament. Divide the dorsal vein and turn the clitoris down. Separate the inferior fascia of the urogenital diaphragm from the margin of the pubic arch on each side, if that has not already been done during the dissection of the perineum. Examine the sphincter urethræ membranaceæ, which lies above the inferior fascia of the urogenital diaphragm. Divide the sphincter urethræ membranaceæ on each side and turn it towards the median plane. Pass a probe into the urethra and note that the anterior fibres of the sphincter pass in front

of the urethra, and that its posterior fibres pass over the wall of the vagina. Above the sphincter urethræ membranaceæ lies the upper fascia of the urogenital diaphragm, which is now seen from the front. Pass a finger into the vagina, and note that both the urethra and the vagina pass through the upper fascia of the urogenital diaphragm, which is reflected upwards along their borders.

Divide the upper fascia of the urogenital diaphragm on both sides, and again note that, at the sides of the urethra and the vagina, it is continuous round the anterior border of the levator ani with the visceral layer of the pelvic fascia.

Divide the pubes on each side, with the saw, along a line commencing on the margin of the pubic arch, below the attachment of the arcuate ligament, and terminating above at the lateral border of the tubercle of the pubis. Pass the knife behind the pubis and separate the visceral layer of the pelvic fascia from its attachment to the bone between the saw cuts. The separated piece of bone may now be removed and should be kept for the examination of the ligaments of the symphysis (see pp. 474, 475). If necessary, a further portion of the margin of the pubic arch may be removed, on each side, to give room for the examination of the relations of the vagina and the urethra.

The dissector should now make his final examination of the pelvic fascia. Tracing the upper surface of the visceral layer medially, he will find that it spreads out on the infero-lateral surfaces and anterior border of the urinary bladder, and that, below the bladder, it covers the front of the urethra and the vagina. The latter part presents a free border where it was detached from the back of the pubes, and beneath that border the dorsal vein of the clitoris can be traced towards the bladder, where it joins the vesical plexus. In that part of the fascia the two thickened bands which form the medial pubo-vesical ligaments will be noted. If the dissector next traces the fascia medially, *following its lower surface*, he will find that it passes behind the rectum, and he will thus demonstrate that the visceral layer of the pelvic fascia splits as it passes towards the median plane, one layer, *the vesical*, passing on to the bladder and in front of the urethra and vagina, and a second layer, *the rectal*, which passes behind the rectum. There is, however, a third layer, *the recto-vaginal*, which crosses between the rectum and the vagina. To demonstrate that layer the dissector should divide the vesical layer in the median plane in front of the bladder, and turn the lateral halves towards the side walls of the pelvis. In that way he will expose the urethra and the anterior wall of the vagina, the two being closely bound together, and when the lateral border of the vagina is reached he will find that the vesical layer of the fascia blends with a deeper layer which passes behind the vagina; that layer is the recto-vaginal layer. On the anterior wall of the vagina, and, more particularly, along its lateral border, the dissector should note a plexus of veins, the *vaginal plexus*.

The recto-vaginal layer of the pelvic fascia should be displayed from below also. To do that the dissector must cut transversely through the tissue of the perineal body, which lies in front of the anal orifice, until he reaches the junction of the anal passage with the rectum. When that point is attained he

will find that he can quite easily separate the rectum from the vagina with his finger, and that intervening between the two is the recto-vaginal layer of fascia which he previously exposed from above.

Before terminating his study of the visceral layer of the

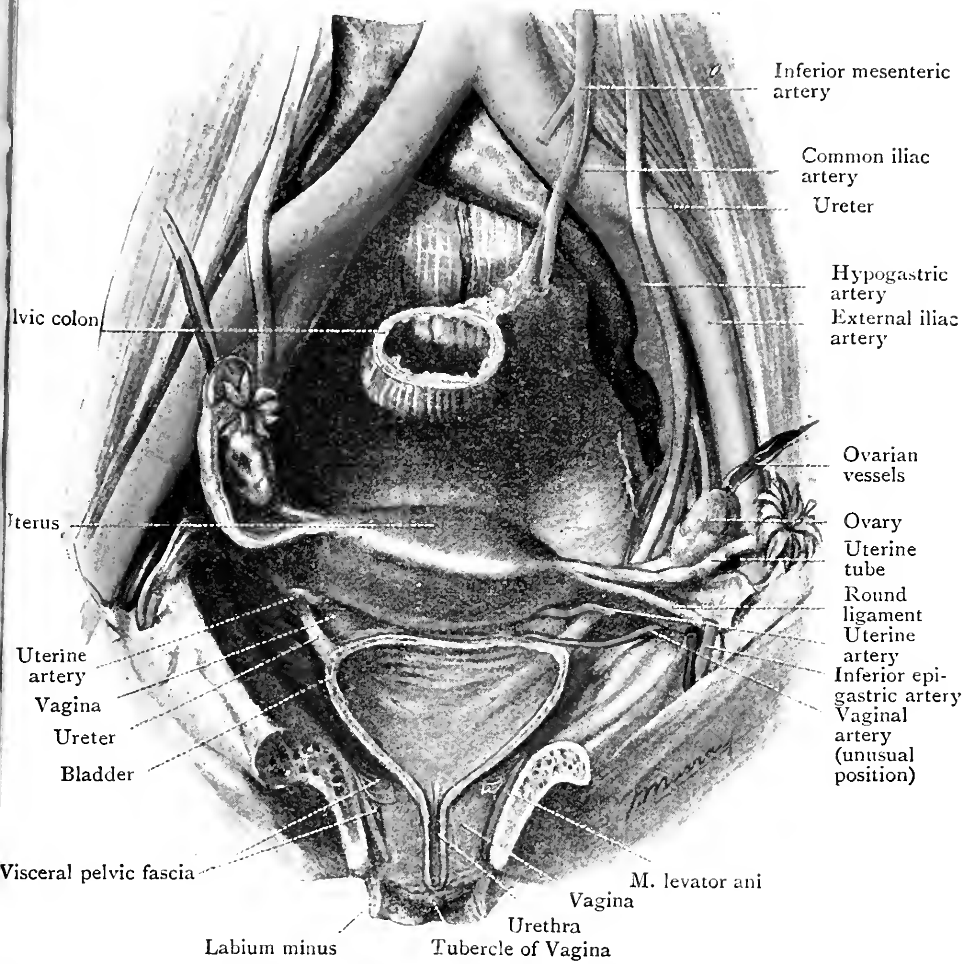

FIG. 225.—Dissection of the Pelvis of a multiparous female, showing the relations of the Bladder to the Uterus and Vagina, the relations of the Vagina to the Urethra and Broad Ligaments, and the relations of the Ureters to the Broad Ligaments and Vagina.

pelvic fascia the student should note that the floor of the pelvic cavity of the female is formed, as in the male, by the levatores ani and the coccygei muscles, and the upper and lower fascial layers of the urogenital diaphragm, but it is pierced by three canals instead of two, viz., the urethra and the anal passage,

as in the male, and, between them, the vagina. In that way the floor of the pelvis, in the female, is rendered relatively weak and less capable of resisting strain, whilst at the same time it is adapted to the function of child-bearing, for it is cleft by the vaginal canal into two segments—an anterior, including the anterior vaginal wall and all the parts in front of it, and a posterior, formed by the posterior vaginal wall and the parts behind it. The former can be lifted into the pelvis and the latter can be forced downwards, much as the two segments of a folding door are displaced in opposite directions, and thus a passage is made for the exit of the child (Berry Hart). The dissector should note also, as a matter of clinical importance, that, whilst the urethra and the anterior wall of the vagina are closely bound together and cannot be separated, except by the use of the knife, the posterior wall of the vagina and the anterior wall of the rectum are only loosely united together, and can easily be torn apart.

Vesica Urinaria.—The urinary bladder, in the female, has normally a smaller capacity, and it lies at a somewhat lower level in the pelvis than the male bladder; but its shape when empty and slightly contracted is the same as in the male, *i.e.*, it has the form of a three-sided pyramid, possessing a *superior surface*, two *infero-lateral surfaces*, a *fundus* or *base*, and an *apex*. The superior surface is covered with peritoneum. It is bounded by two lateral borders, which separate it from the infero-lateral surfaces, and by a posterior border, which separates it from the base. The two lateral borders converge anteriorly and meet at the *apex*, from which a fibrous cord, the middle umbilical ligament or urachus, passes up the posterior surface of the anterior abdominal wall to the umbilicus. The urachus is the remains of part of the cloaca of the fœtus. The lateral borders meet the posterior border of the upper surface at the *posterior angles* of the bladder, where the ureters enter the wall of the viscus. The infero-lateral surfaces, and the anterior border, which separates them, are devoid of peritoneum. They form the posterior wall of the lower part of the cave of Retzius, and are separated from the back of the symphysis and the pelvic surfaces of the pubic bones by a layer of loose, extra-peritoneal fat. The term *retro-pubic pad* is applied to that portion of the fatty tissue which intervenes between the back of the symphysis pubis, the upper surfaces of the medial pubo-vesical ligaments, and

the anterior border of the bladder. To examine the relation of the fundus of the bladder to the uterus and vagina, the student must cut through the peritoneum at the bottom of the vesico-uterine pouch, and then separate the bladder from the front of the neck of the uterus and the upper part of the anterior wall of the vagina. Whilst he is dividing the peritoneum he should notice that the membrane may extend down over the fundus of the bladder for a very short distance.

The False Ligaments of the Urinary Bladder.—As in the male, there are five false ligaments of the bladder, two *lateral*, two *posterior*, and one *superior*. They are all formed by the peritoneum. The two *lateral* are merely the parts of the peritoneal membrane which connect the lateral borders of the superior surface of the bladder with the side walls of the pelvis; they form the floors of the paravesical fossæ. The *superior*, or middle umbilical fold, is the fold of peritoneum which is raised up by the middle umbilical ligament; and the two *posterior* are the ill-marked folds which pass from the upper part of the base of the bladder to the front of the neck of the uterus; they form the lateral boundaries of the vesico-uterine pouch. The dissector should compare the false ligaments of the urinary bladder of the female with the corresponding false ligaments in the male (see p. 413).

The True Ligaments of the Urinary Bladder.—The true ligaments of the urinary bladder are five in number, two *anterior*, two *lateral*, one *superior*. The lateral and the anterior ligaments are portions of the visceral layer of pelvic fascia. The lateral pubo-vesical ligaments are merely the lateral parts of the vesical lamella; whilst the anterior or medial pubo-vesical ligaments are thickenings of the anterior part of the same lamella, one on each side of the median plane. The lateral connect the infero-lateral surfaces of the bladder to the main layer of the visceral pelvic fascia, and indirectly to the side wall of the pelvis. The anterior bind the anterior border of the bladder to the back of the symphysis pubis. It is doubtful if the term superior true ligament is properly applied, but it is sometimes given to the middle umbilical ligament, which connects the apex of the bladder with the anteiror abdominal wall.

Dissection.—To examine the interior of the bladder, the dissector should make an incision through the anterior border,

and through the infero-lateral surfaces immediately below their junction with the superior surface. When that has been done the superior surface should be raised and the anterior border and infero-lateral surfaces should be depressed; a good view of the interior will then be obtained. The mucous membrane should be cleaned with a sponge and its general characters and the orifices of the bladder should be studied.

The Mucous Membrane, the Trigone, and the Orifices of the Urinary Bladder.—Over the greater part of the inner surface of the empty bladder the mucous membrane is rugose, on account of the laxity of its connection with the muscular coat; but in a triangular area on the lower part of the fundus, which is known as the *trigone*, the connection is closer and the mucous membrane is always smooth. The rugæ on the other parts of the inner surface become unfolded as the bladder distends, until the whole inner surface is smooth. The trigone is also the most sensitive area of the bladder wall. At its apex, which marks the lowest point of the base of the bladder, is situated the semilunar or Y-shaped *internal orifice of the urethra*; and at its lateral angles, which are about one inch from each other and the same distance from the orifice of the urethra, lie the slit-like orifices of the ureters. The student should pass probes into the ureters; he will then be able to convince himself that each ureter runs for about three-quarters of an inch in the substance of the bladder wall, and that that part of each duct can be easily palpated through the anterior wall of the vagina. The obliquity of the ureters in the substance of the bladder wall is believed to produce a valve-like action of the lower parts of the ducts, permitting the passage of urine into the bladder, but preventing its return.

Relations of the Bladder.—Each infero-lateral surface forms a part of the posterior wall of the cave of Retzius, and it is separated by extra-peritoneal fat from the back of the body of the pubic bone and from the fascia covering the pelvic surfaces of the corresponding obturator internus and levator ani muscle. The anterior border, which separates the infero-lateral surfaces, lies behind the symphysis and above the medial pubo-vesical ligaments. The neck of the bladder, which lies at the meeting of the infero-lateral surfaces and the lower angle of the fundus, is closely bound to the anterior surface of the vagina, whilst in the male it is embraced by the base of the prostate (see p. 443).

The superior surface, which is in relation, in the male, with coils of small intestine and pelvic colon, is overhung posteriorly by the uterus in the female, and is in relation with small intestine or a coil of the pelvic colon only in the anterior part of its extent. The fundus of the urinary bladder, which, in the male, is in relation with the deferent ducts and the seminal vesicles, is closely bound, in the female, to the anterior surface of the neck of the uterus and to the upper part of the anterior wall of the vagina (Fig. 220).

Peritoneal Relations.—The peritoneal relations of the urinary bladder are the same in the female as in the male (see p. 445). The alterations in the peritoneal relations which occur as the bladder distends are the same in both sexes (see p. 446).

Changes in the form of the Bladder.—The changes which occur in the form of the bladder as it passes from the empty to the distended condition are the same in the female as in the male (see p. 443).

Urethra Muliebris (Female Urethra).—The urethra is the canal by which the urine leaves the bladder. Its length is about 38 mm. (one and a half inches). It takes a slightly curved course from the neck of the bladder downwards and forwards to the vestibule, where it opens on the surface by an aperture called the *orificium urethræ externum.* The orifice usually presents the appearance of a vertical slit, and lies immediately in front of a prominent projection of the mucous membrane at the lower extremity of the anterior vaginal wall. The projection is easily felt, and when the finger is passed over the vestibular area the position of the external orifice is readily localised. On its way to the surface the urethra passes through the two fasciæ of the urogenital diaphragm, and in the interval between them it is surrounded by the fibres of the sphincter urethræ membranaceæ muscle. In the whole of its length it is closely bound to the anterior wall of the vagina, and its walls are in close apposition, except when the passage is opened by the flow of urine through it.

The urethra should be split open longitudinally so that its coats can be examined. They are—(1) a muscular coat; (2) a submucous coat; (3) a mucous coat. The muscular coat consists of an outer layer of circular and an inner layer of longitudinal fibres. The circular fibres are strongly

developed in the region of the neck of the bladder, where they form a distinct sphincter. The submucous coat connects the mucous coat loosely with the muscular coat. The mucous coat is thrown into longitudinal folds. It contains a number of gland follicles and lacunæ, and, in addition, there are present in its ventral wall two longitudinal tubules, called the *para-urethral ducts.* They open either into the urethra close to its external orifice, or directly into the vestibule close to the orifice.

The Ureters.—The portions of the ureters, which lie in the pelvis minor in the female, are slightly longer than the corresponding parts in the male, owing to the greater width of the pelvis and to the greater depth at which the bladder lies.

In the female, as in the male, the pelvic portion of each ureter first descends, along the side wall of the pelvis immediately in front of the hypogastric artery, and then turns forwards and medially, towards the bladder, resting upon the upper surface of the levator ani. As it descends its relations are in the main similar to those of the corresponding part of the ureter in the male. Immediately behind it is the hypogastric artery. Lateral to it, from above downwards, lie the medial margin of the psoas major muscle, the umbilical artery,[1] the obturator nerve, and the obturator vessels. Its anterior and medial borders are covered with peritoneum. The anterior border is in relation with the corresponding ovary. It forms the posterior boundary of a shallow depression, on the side wall of the pelvis minor, in which the ovary is lodged and which is called, therefore, the ovarian fossa. The medial, peritoneal covered border of the right ureter is in relation with coils of small intestine, and the corresponding border of the left ureter is in relation with the pelvic colon.

The relations of the lower part of the pelvic portion of the ureter, which runs medially, are very different in the two sexes. In the female that portion of the ureter runs forwards and medially and passes obliquely beneath the lower border of the broad ligament and obliquely across the side and front of the upper end of the vagina (Fig. 225), and it enters the corresponding posterior angle of the bladder about 50 mm. (two inches) from its fellow of the opposite side. Beneath the broad ligament, and at the lateral border of the upper end of

[1] The relative positions of the umbilical artery and the obturator nerve may be reversed.

the vagina, the uterine artery crosses above it, and, just before it enters the bladder, it lies immediately in front of the upper part of the anterior vaginal wall (Fig. 225). When the bladder is distended and the vagina is narrow the posterior angles of the bladder may extend beyond the lateral borders of the vagina; in such cases the relations of the ureters to the

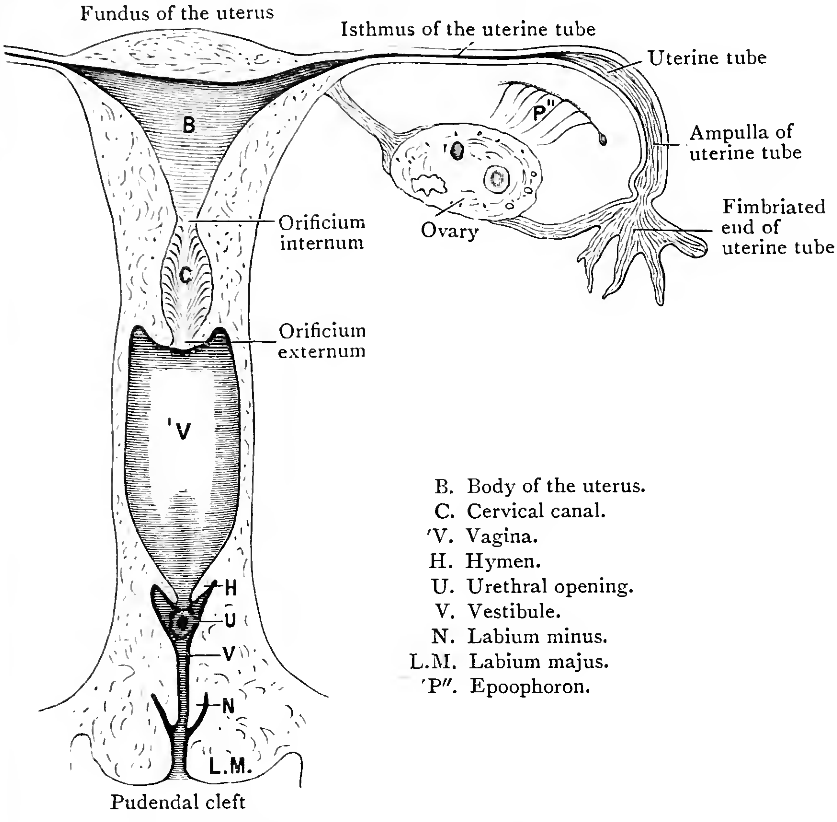

FIG. 226.—Diagram of the Vulva, Vagina, and the Uterus, with its Appendages. (Symington.)

vagina are much less intimate. For the relations of the corresponding part of the male ureter see p. 447.

Uterus. — The uterus is the organ in which the impregnated ovum is retained until the fœtus is fully developed. It lies in the middle part of the pelvis, resting upon the posterior part of the upper surface of the bladder, and lying beneath coils of small intestine. It is of modified piriform shape, being flattened from before backwards. In length it measures about 75 mm. (three inches), and its long axis lies

in the axis of the upper aperture of the pelvis minor, and almost at right angles with the long axis of the vagina (Fig. 224). Its *breadth*, at the broadest part, is about 50 mm. (two inches), and its greatest *thickness* is 25 mm. (one inch). Its broad, upper end is directed upwards and forwards, and is continuous at each side with a uterine tube. Its narrower, lower end, which is directed downwards and backwards, passes through the upper part of the anterior vaginal wall into the cavity of the vagina.

It is customary to describe the uterus as consisting of three parts, viz., a fundus, a body, and a cervix.

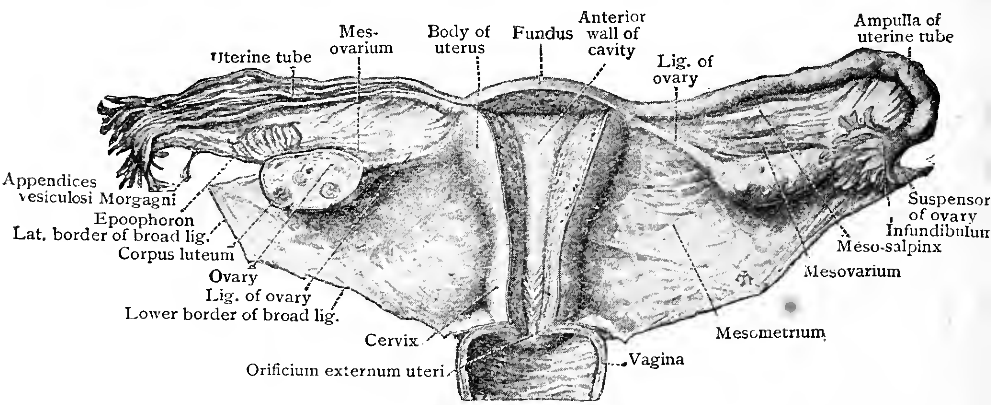

FIG. 227.—The Uterus, the Uterine Tubes, the Ovaries, the Broad Ligaments, and the upper part of the Vagina, seen from behind. The posterior wall of the uterine cavity has been removed, and the left Uterine Tube and the upper part of the Vagina have been opened.

Fundus Uteri.—The fundus is that portion of the rounded upper end which lies above a line drawn transversely across the organ between the points where the uterine tubes enter. It is completely covered with peritoneum.

Corpus Uteri.—The body of the uterus diminishes in breadth as it proceeds downwards to the neck. In front and behind, it is convex, the convexity of the posterior surface, however, being much more marked, especially in its upper part, than that of the anterior surface. Each border is connected to the corresponding broad ligament, and immediately below the entrance of the uterine tube it is joined, in front, by the *round ligament*, and, behind, by the *ligament of the ovary*. Inferiorly, the body of the uterus is marked off from the cervix by a slight constriction, which, although very

apparent in the infant, becomes less distinct as puberty approaches, and usually disappears altogether after parturition. This constriction is called the *isthmus*.

Cervix Uteri.—The cervix, or neck, of the uterus is about 25 mm. (one inch) in length; it is narrower than the body and more cylindrical in form. It projects into the upper end of the vagina, the walls of which are attached around it.

To obtain a satisfactory view of the relation of the uterus to the vagina, both organs should now be split sagittally, care being taken to avoid injuring the rectum. When the section has been made, the posterior wall of the vagina will be found to ascend to a higher level on the cervix than the shorter anterior wall (Figs. 224, 229). On the lower extremity of the cervix, which rests against the posterior vaginal wall, there is an orifice, the *orificium externum uteri* (O.T. *os uteri externum*). The orifice, in nulliparæ, is always a small transverse slit, with rounded anterior and posterior lips, but in women who have borne children it is usually larger, and its margins are more irregular in outline. The anterior lip is the shorter, and it is placed at a lower level in the vagina. The difference in the level and in the length of the two lips is due to the fact that the uterus passes obliquely through the vaginal wall. The part of the cervix which projects into the vagina is the *vaginal portion*; the part above is termed the *supravaginal portion.*

Cavum Uteri.—The cavity of the uterus is separable into two parts, the cavity of the body and the cavity of the cervix. The cavity of the body is a mere cleft, triangular in outline, which lies between the anterior and posterior walls. The base of the triangle is above, and at each of its angles a uterine tube opens into the cavity. The apex is below, where the cavity of the body joins the cavity of the cervix, at a constricted aperture of communication called the *orificium internum uteri* (O.T. *os uteri internum*).

The cervical portion of the cavity is spindle-shaped and slightly compressed from before backwards. It extends from the internal orifice, where it is continuous with the cavity of the body, to the external orifice, where it opens into the vagina.

The Relations of the Uterus.—The posterior surface of the uterus is completely covered with peritoneum, and it is separated from the rectum by the recto-vaginal pouch, in which lie

coils of the small intestine and part of the pelvic colon. The anterior surface of the body, which rests on the bladder, is also covered with peritoneum, but the anterior surface of the cervix is devoid of peritoneum, and is in direct relation with

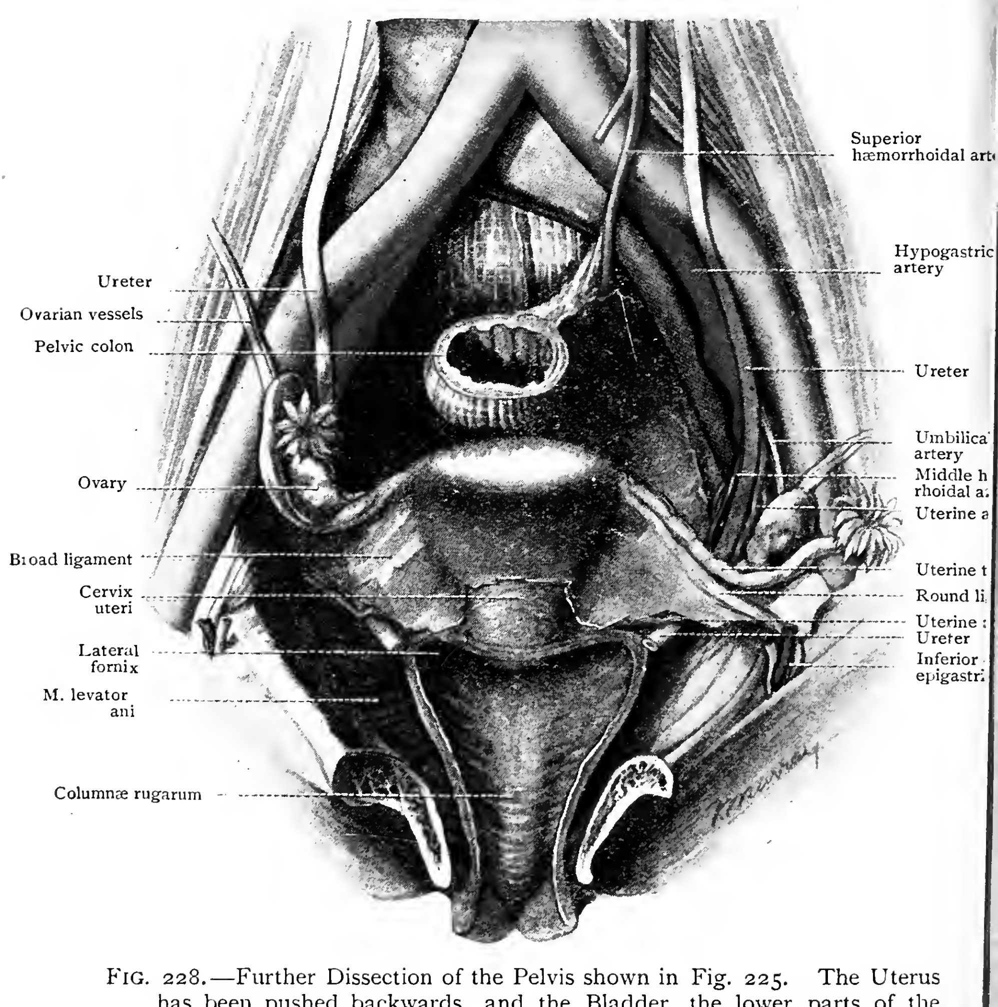

FIG. 228.—Further Dissection of the Pelvis shown in Fig. 225. The Uterus has been pushed backwards, and the Bladder, the lower parts of the Ureters, and the anterior wall of the Vagina have been removed.

the fundus of the bladder. The lateral borders of the uterus are connected with the broad ligaments, and between the layers of the ligaments each is associated with the corresponding uterine artery, and uterine plexus of veins, which are embedded in a mass of loose fatty tissue called the *parametrium.* The parametric tissue is most abundant in the

region of the upper part of the vagina and at the side of the neck of the uterus.

Ligamenta Teretia Uteri (Round Ligaments).—The round ligaments of the uterus are two cord-like bands, one on each side, composed of involuntary muscle fibres and connective tissue. They are attached to the body of the uterus, immediately below and in front of the entrance of the uterine tubes. Each ligament runs forwards and laterally from the uterus, in a fold of the anterior layer of the corresponding broad ligament, to the side wall of the pelvis. There it lies for a short distance on the external iliac vessels, and then turns round the inferior epigastric artery, and passes through the abdominal inguinal ring into the inguinal canal, where it has already been examined. It represents the lower part of the gubernaculum of the ovary, the upper part being represented by the ligament of the ovary.

Position of the Uterus.—In women who have borne no children (nulliparæ), and in whom the bladder and the rectum are both empty, the uterus is normally *anteflexed* and *anteverted.* The statement that the uterus is anteflexed means that it is bent forwards on itself at the isthmus, so that the body and the cervix meet at an angle which is open in front. This forward flexion depends upon two circumstances, viz.—(1) upon the greater pliability of the body as compared with the firmer consistence and greater resistance of the cervix; and (2) upon the fact that the cervix is more or less held in position by its attachments to the anterior vaginal wall and the fundus of the bladder in front, and to the posterior vaginal wall behind. The term anteversion means that the whole uterus—body and cervix—is inclined forwards and forms an angle of greater or less magnitude with the vertical axis of the trunk. When the uterus is in its usual position, coils of small intestine and a loop of the pelvic colon rest upon its posterior surface, and its anterior surface is supported by the bladder. It is only on rare occasions that a coil of small intestine is found between the uterus and the bladder, in the vesico-uterine pouch of peritoneum. In multiparæ (women who have borne children) the anteflexion is not so marked as in nulliparæ.

The uterus possesses a great degree of mobility, however, and its position is constantly liable to change, but under no circumstances does it occupy an exactly median position.

As a rule, its anterior surface is directed forwards and to the right. The ordinary anteflexion and anteversion may be diminished or exaggerated by alterations of the general intra-abdominal pressure, and by distension of the bladder and the rectum. They may be altered also by pathological contractions of the peritoneal ligaments connected with the uterus, or of the connective tissue between the folds of the ligaments. Every contraction of the diaphragm, every movement of the body, is accompanied or followed by some slight change in

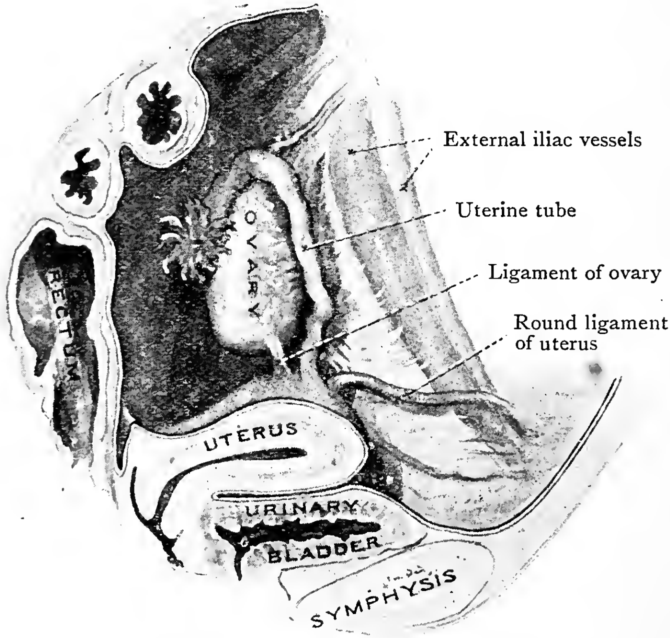

FIG. 229.—Left Side Wall of Female Pelvis to show position of the Ovary. The ovary is much scarred owing to the shedding of ova.

the position of the uterus. When the bladder fills, the uterus is raised, the anteflexion and anteversion become less marked, and, in cases of over-distension of the bladder, the uterus may assume an erect position, or may be even forced backwards until it lies in the same line as the vagina. When the uterus attains the last-mentioned position it is said to be *retroverted.* As it becomes retroverted the coils of intestine are displaced from the recto-vaginal pouch, and the uterus is forced into intimate relation with the rectum. When the rectum becomes distended the uterus is pushed forwards and usually to the right side.

***Dissection.*—When the examination of the relations of the uterus is concluded, the dissector should cut through the rectum in the median plane. Then, with the saw, he should divide the sacrum and coccyx to the left of the middle sacral vessels, and when that has been done he should cut through all the remaining tissues in the same plane and separate the two halves of the pelvis. All the remaining stages of the dissection and examination can be carried out on each half separately.**

Vagina.—The vagina is the passage which leads from the uterus to the vulva. It is about 75 mm. (three inches) long, and it is widest at its upper end. Its distensibility is very great, to allow the passage of the child during parturition. The direction of the canal, when the bladder and rectum are empty, is from above downwards and forwards, parallel with the plane of the superior aperture of the pelvis minor, so that it forms with the uterus an angle which is open towards the symphysis. Its anterior and posterior walls are closely applied, and in section, therefore, its cavity appears either as a transverse or as a longitudinal slit, according to the direction in which it is divided (Figs. 221 and 224).

At its upper end the vagina is attached round the neck of the uterus, upon which it ascends farther posteriorly than anteriorly, so that the uterus appears to pierce the anterior wall of the vagina. The shallow sulcus at the upper end of the cavity of the vagina, around the neck of the uterus, is known as the *fornix* of the vagina. It is formed by the reflection of the mucous membrane of the vagina on to the neck of the uterus, and is separable into anterior, posterior, and lateral parts. The dissector should examine carefully the relations of the fornices. The *anterior fornix* is in relation with the base of the bladder. The *posterior fornix* is in relation with the recto-vaginal pouch of peritoneum, and therefore an injury of the vagina in that region may open into the lower part of the peritoneal cavity. Each *lateral fornix* lies below the lower medial angle of the broad ligament, and is in close relation with the ureter, the uterine artery, and the mass of fatty, vascular tissue, previously mentioned as the parametrium.

The opening of the lower end of the vagina into the urogenital cleft is partly closed, in the virgin, by the *hymen*. The hymen is formed by two antero-posteriorly placed crescentic folds of mucous membrane which are united in front and behind. After the hymen has been ruptured, its

torn fragments, called *carunculæ hymenales*, persist round the opening.

The Relations of the Vagina.—The posterior wall of the vagina is in relation, above, with the recto-vaginal pouch of peritoneum. Below that pouch, it is in apposition with the anterior wall of the rectum (Fig. 224). The anterior wall of the vagina is related to the lower part of the base of the bladder and to the urethra. The lower end of the vagina is

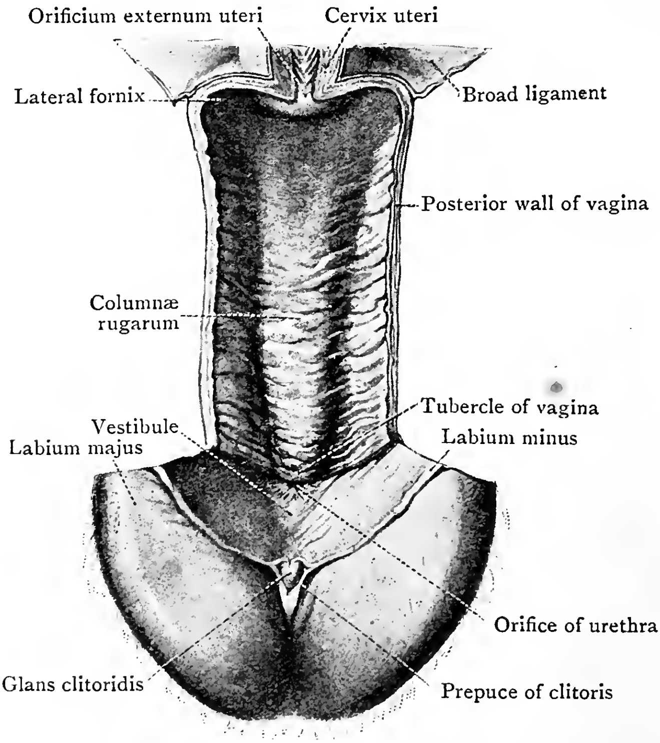

FIG. 230.—The lower part of the Cervix Uteri, the anterior wall of the Vagina, and the Vestibule. The Vagina has been opened from behind.

embraced between the vestibular bulbs, and is clasped by the bulbo-cavernosus, which acts as a sphincter, and each lateral border is supported by the corresponding levator ani muscle. The anterior borders of the levatores ani muscles, as they pass backwards from the pubic bones to the central point of the perineum, closely embrace the vagina, and act as a superior or second sphincter of the canal (Figs. 225, 228).

Tubæ Uterinæ (O.T. **Fallopian Tubes**).—There are two uterine tubes, one on each side, and their function is to

convey ova from the ovaries to the uterus. Each uterine tube is about 10 cm. (four inches) long, and it is contained, in the greater part of its length, in the medial four-fifths of the upper border of the broad ligament. Its medial end pierces the uterus at the junction of the body and fundus. At a short distance from its lateral end it pierces the posterior surface of the broad ligament, curls over the upper pole of the ovary, and opens into the peritoneal cavity by a constricted orifice, the *ostium abdominale*, which is surrounded by a number of fringe-like processes called the *fimbriæ*. By one of the fimbriæ, the *fimbria ovarica*, it is attached to the tubal or upper pole of the ovary. Its calibre is by no means uniform. As it is traced from the uterus it is at first very narrow, scarcely admitting a bristle. That portion is called the *isthmus tubæ uterinæ*. More laterally the tube dilates considerably, and becomes convoluted and less closely attached to the peritoneum of the broad ligament. The dilated part is called the *ampulla tubæ uterinæ*. The ampullary portion of the tube terminates at the *ostium abdominale* which opens into the cavity of the *infundibulum tubæ*. The walls of the infundibulum are cleft into a number of processes called the *fimbriæ*, therefore the cavity of the infundibulum is very freely continuous with the cavity of the abdomen. The longest of the fimbriæ is attached to the ovary and, as already stated, it is called the *ovarian fimbria*. It is attached along its whole length to the broad ligament. On its surface is a gutter-like groove leading from the constricted mouth of the tube to the ovary. Traced from the uterus, the tube runs first laterally, then, at the side wall of the pelvis, it turns upwards, and finally, having gained the upper pole of the ovary, it bends downwards and covers the posterior free border and the greater part of the medial surface of the ovary (Fig. 229).

Ovaria.—The ovaries are two small, solid bodies, each of which is attached to the posterior surface of the corresponding broad ligament, by a secondary fold of the posterior layer of the ligament called the *mesovarium*. Each ovary has the form of a slightly compressed ovoid, and is about the size of a pigeon's egg. It presents two flattened surfaces, two extremities or poles, and two borders.

Its natural or typical position can be studied only in women who have borne no children, for the ovaries become

displaced during pregnancy, and it is doubtful if they ever regain their original positions. In the nulliparous female each ovary occupies a peritoneal fossa on the back part of the side wall of the pelvis, below the external iliac vessels and in front of the hypogastric vessels and the ureter. The recess is termed the *fossa ovarica.* The long axis of the ovary is vertical. From its *upper pole* the suspensory ligament of the ovary passes to the side wall of the pelvis, and to the same extremity the mouth of the uterine tube is attached by the ovarian fimbria of the infundibulum of the uterine tube; on account of the latter connection the upper pole is frequently called the *tubal extremity* of the ovary. The lower or *uterine extremity* is connected with the lateral border of the uterus, immediately below and posterior to the entrance of the uterine tube, by the round cord-like *ligament of the ovary*, which lies in the medial part of the mesovarium, and is a remnant of the gubernaculum of the ovary. The *anterior border* is commonly called the *attached border* or *hilum*, because it is connected to the back of the broad ligament by the mesovarium, and because, through it, the vessels and nerves pass into and out of the ovary. The *posterior border* of the ovary is free, and looks backwards towards the ureter. The medial surface of the right ovary is in relation with a coil of the small intestine, and the medial surface of the left ovary is in relation with the pelvic colon. The lateral surface of each ovary, in the nulliparous female, lies against the side wall of the pelvis minor.

In the natural position of the organs the uterine tube encircles the greater part of the circumference of the ovary.

On each surface of the ovary, close to the anterior border, a white line marks the transition of the flat endothelial cells of the peritoneum into the cubical epithelium of the surface of the ovary. Before puberty the surface of the ovary is smooth; after that period it becomes scarred and puckered by the cicatrices which mark the positions of the ruptured Graafian or vesicular ovarian follicles from which ova have escaped.

Epoophoron (O.T. **Parovarium**).—The epoophoron is a structure of interest because it represents the lobules of the epididymis and part of the duct of the epididymis of the male. The dissector will find it by stretching the broad ligament, holding it to the light, and examining the lateral part, between the ovary and the uterine tube. It lies between the layers of

the broad ligament, and consists of a horizontal tubule and a series of vertical tubules. The vertical tubules radiate from the region of the hilum of the ovary to the horizontal tubule, in which they terminate. The horizontal tubule lies about midway between the ovary and the uterine tube, and runs parallel with the latter. Traced towards the uterus, it is found to end blindly. Laterally, it may end in a similar manner, or it may pierce the posterior layer of the broad ligament and end in a dilated vesicle, of piriform shape, called the *vesicular appendix* or *hydatid of Morgagni.* The vesicular appendix may be attached to one of the fimbriæ of the uterine tube.

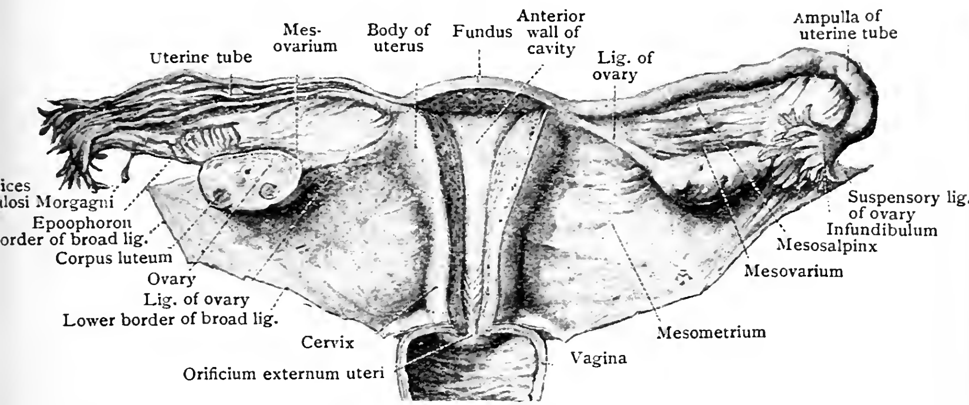

FIG. 231.—The Uterus, with the Broad Ligaments stretching out from its sides.

The Rectum.—A detailed account of the rectum in the male is given on p. 436; the student should read that account and then note the points of difference in the female.

In the upper part of its extent the rectum of the female is separated from the uterus and vagina by the recto-vaginal pouch of peritoneum and the coils of intestine which it contains. Below the bottom of the pouch the rectum is in apposition with the posterior wall of the vagina, the layer of recto-vaginal fascia alone intervening. The connection between the rectal and vaginal walls is very loose above, but is closer below. The arrangement has an important bearing upon the manner in which prolapse of the uterus occurs.

The Anal Canal.—The anal canal bends downwards and backwards from the rectum. It commences about 38 mm.

(one inch and a half) in front of the tip of the coccyx and terminates at the anal orifice. An angular area is thus left between the anterior wall of the canal and the back of the urogenital cleft; it is occupied by a pyramidal mass of firm fibro-muscular tissue called the *perineal body*.

The Blood-vessels of the Pelvis Minor.

The manner in which the blood-vessels of the pelvis minor should be dissected has been described on p. 452. In the female, the dissector will find three arteries which were either not studied at all, or not under the same name, in the dissection of the male pelvis minor, viz.—

1. The uterine, } branches of the hypogastric.
2. The vaginal, }
3. The ovarian, from the abdominal aorta.

Arteria Uterina.—The uterine artery springs either from the anterior division of the hypogastric or from the umbilical artery. It runs downwards, in front of the vertical part of the pelvic portion of the ureter, and then medially along the lower border of the broad ligament and above the lower part of the ureter (Figs. 224, 228). Having crossed the ureter, it passes above the lateral fornix of the vagina and turns upwards along the side of the uterus. It ends by anastomosing with branches of the ovarian artery beneath the isthmus of the uterine tube. It gives branches to the uterus, the vagina, and the isthmus of the uterine tube, and frequently it supplies twigs to the ovary.

Arteria Vaginalis.—The vaginal artery springs from the anterior division of the hypogastric artery. It probably represents the inferior vesical artery of the male, and whilst it is distributed mainly to the vagina it gives twigs also to the base of the bladder and to the rectum.

Arteria Ovarica.—The ovarian artery corresponds to the internal spermatic artery of the male, and the abdominal part of its course is similar to that of the latter artery (p. 392). When it arrives at the pelvis it crosses the *upper part* of the external iliac vessels, and insinuates itself between the two layers of the broad ligament where they form the suspensory ligament of the ovary. It is highly tortuous, and is enclosed, in the terminal part of its extent, in the coils of the *pampiniform plexus* formed by the veins which issue

from the hilum of the ovary. Its terminal branches are distributed mainly to the ovary, which they enter at the hilum, but some pass on to anastomose with branches of the uterine artery. It supplies twigs to the uterine tube also.

The remaining arteries of the female pelvis correspond very closely to those of the male, of which descriptions will be found on pp. 454-458.

The Veins of the Pelvis.—Little requires to be said beyond what was stated regarding the veins of the male pelvis minor on p. 458. The pudendal plexus, into which the *dorsal vein of the clitoris* opens, is smaller than in the male, but is connected in a similar manner with the vesical plexus.

A bulky *uterine venous plexus* is formed on each side of the uterus, between the two layers of the broad ligament. The plexus takes part in the formation of the parametrium, and from its lower part the blood is drained away by one or more uterine veins which end in the hypogastric vein.

A *vaginal venous plexus* is also formed around the vagina. It is most dense along each lateral border, in the angle between the vesical and the recto-vaginal layers of the pelvic fascia. One or more *vaginal veins* proceed from its upper end on each side; they end in the hypogastric veins.

A *pampiniform plexus of veins* is formed by the veins which issue from the hilum of the ovary. It lies between the layers of the broad ligament, and from it two *ovarian veins* issue. They accompany the ovarian artery, and ultimately fuse into a single vein which ends in a manner similar to the corresponding internal spermatic vein of the male (p. 392).

The Pelvic Lymph Vessels.—The lymph vessels of the bladder and rectum are the same in the female as in the male (see p. 459); but, in the female, the lymph vessels of the vagina, uterus, uterine tubes, and ovaries, have also to be considered. Lymph vessels from the lower part of the vagina pass to the superficial subinguinal and to the sacral lymph glands. From the middle and upper parts of the vagina and from the cervix uteri they pass to the hypogastric, the external iliac and the sacral lymph glands. From the body of the uterus they pass to the external iliac and hypogastric lymph glands and along the round ligament to the superficial subinguinal lymph glands. The lymph vessels from the upper part of the uterus and from the ovary terminate in the lymph glands around the aorta.

The Visceral Nerves of the Pelvis.

Very little requires to be added to what has already been said about the visceral nerve plexuses (p. 464). There is no *prostatic plexus*; but a *vaginal plexus*, an *ovarian plexus*, and a *uterine plexus* are present in addition to those mentioned in the description of the male pelvis.

The *uterine plexus* proceeds from the pelvic plexus. It ascends between the layers of the broad ligament, along the uterine artery, and is distributed to both aspects of the uterus.

The *vaginal plexus* is also an offset from the pelvic plexus, and the nerves which compose it are derived mainly from the visceral branches which enter the pelvic plexus from the third and fourth sacral nerves.

The *ovarian plexus* is derived from the aortic and renal plexuses. It accompanies the artery of the same name, and is distributed to the ovary.

Dissection.—When the blood-vessels and the visceral nerve plexuses have been examined, the pelvic viscera should be removed. The vessels and nerves passing to them must be cut; the visceral layer of pelvic fascia on the upper surface of the levator ani must be divided, from before backwards, and stripped medially from the upper surface of the muscle. Finally, the rectum must be separated from the upper end of the anal canal, and then the viscera can be removed. When that has been done the structure of the walls of the viscera should be studied.

Structure of the Uterus.—The uterus possesses three well-marked coats—a serous or peritoneal, a muscular and a mucous. The *serous covering* has already been fully studied (p. 495). The *muscular part* of the wall constitutes its chief bulk. It is composed of involuntary muscular tissue, with a considerable admixture of areolar tissue. It is not equally thick throughout, and is relatively thin towards the angles or points where the uterine tubes open into the uterus.

The *mucous membrane* which lines the cavity is not of uniform appearance. In the body of the uterus it is smooth and closely bound to the adjacent muscle. In the cervix it presents a striking arrangement, which from its appearance has been termed the *arbor vitæ*. The arbor vitæ consists of a series of prominent folds or rugæ, called *plicæ palmatæ*, arranged in a definite manner. There is a median fold on the anterior and another on the posterior wall of the canal.

Secondary folds branch off from each median fold and pass obliquely upwards and laterally. The plicæ palmatæ are better marked on the anterior than on the posterior wall. Between the plicæ palmatæ the dissector may discover some minute vesicles filled with yellowish fluid; these are the *ovula Nabothi.* They result from the obstruction of the mouths and the distension of the cavities of certain tubular glands which lie in the mucous membrane.

The Coats of the Vagina.—The vagina possesses an external muscular coat, an internal mucous coat, and an intermediate layer of cavernous tissue. The muscular coat is formed of unstriped muscle fibres arranged in two layers, an external longitudinal layer and an internal circular layer, of which the former is much the stronger. The mucous membrane presents two well-marked median longitudinal folds, one on the anterior, and one on the posterior wall. They are termed the *columnæ rugarum*, and from each side they send off numerous transverse ridges, which are arranged so that those of the anterior wall fit in between those on the posterior wall. The folds are best marked near the vaginal orifice, and are absent at the upper part of the canal. The intermediate layer of cavernous tissue is thin.

Structure of the Uterine Tubes.—Each uterine tube has an external serous, an intermediate muscular, and an internal mucous lining coat. The serous coat is the peritoneal covering formed by the layers of the broad ligament. The muscular coat consists of an external longitudinal and an internal circular layer of unstriped muscle fibres. The tube is so narrow in the region of the isthmus that the mucous membrane in that region can be satisfactorily examined only in sections and with the aid of the microscope, but the ampulla is easily opened, and when that has been done the dissector will recognise that the mucous membrane is arranged in longitudinal folds. To obtain a proper idea of the fimbriæ the tube should be immersed in water, when they will float out and separate from each other.

The Coats of the Rectum and Anal Canal.—The coats of these portions of the intestinal canal are identical in both sexes. The student should refer, therefore, to p. 466, where the walls of the male rectum and anal canal are described.

Dissection.—When the dissector has completed his study of the structure of the pelvic viscera he should return to the

investigation of the pelvic spinal nerve plexuses, and the sympathetic trunk, and the coccygeal glomus (see p. 461). After he has satisfied himself regarding the formation and distribution of the plexuses, and the position and connections of the sympathetic trunk, he should study the pelvic diaphragm.

The sacral, the pudendal, and the coccygeal nerve-plexuses are the same in both sexes, and the description of their constitution and relations will be found on pp. 461 and 462.

The pelvic portions of the sympathetic trunks are described on p. 464.

The position and constitution of the coccygeal glomus are given on p. 465.

The Pelvic Diaphragm.

The pelvic diaphragm is described on pp. 459, 460. The dissector should note that the levator ani muscle passes downwards and backwards and that it gives support to the lateral border of the vagina; he should note also that the anterior borders of the two levatores ani muscles embrace the lower part of the vagina very closely, and exert a sphincter action upon it.

Dissection.—After he has studied the pelvic diaphragm the dissector should remove the levator ani to display the obturator internus, and examine the attachment and arrangement of that muscle (see p. 468). He should then study the piriformis (see p. 468), and should complete his dissection of the pelvis by an examination of the pelvic articulations.

The Pelvic Articulations.—The pelvic joints are described at p. 469. In the later months of pregnancy the ligamentous structures of the various pelvic joints become softened and thickened by the infiltration of fluid. The pelvic bones are thus separated from each other to some extent, and the calibre of the pelvic canal is increased, in preparation for the passage of the child.

INDEX.

END OF VOL. II